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JPRS-UMM-85-008

16 July 1985

# USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT

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16 July 1985

## USSR REPORT

### MACHINE TOOLS AND METALWORKING EQUIPMENT

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## INDUSTRY PLANNING AND ECONOMICS

### BAL'MONT ON COMPETITIVENESS OF SOVIET MACHINE TOOL

Moscow SOVIET EXPORT in English No 1, Jan-Feb 85 pp 3-5

#### [Text]

The technological progress of Soviet machine building, which ranks first in Europe and second in the world in production volume, is based on the dynamic progress of the USSR's machine-tool building and cutting-tool industry. The development of advanced machine tools, increase in their types and sizes, and growth of their production have made it possible to form a powerful and modern stock of metalworking equipment in this country.

Over the period 1975—1983, the production of metalcutting machine tools increased 1.7 times in value terms, including a 3.7-fold rise in the output of numerically-controlled machines. The output of metalforming machine tools grew 1.7 times.

The results of the first three years of the current five-year plan period (1981—1985) show that the stipulated rate of growth in the production of metalworking equipment is steadily maintained.

The output of numerically-controlled machine tools went up 1.5 times during 1981—1983. The industry is being steadily restructured, both technologically and organizationally, with a view to producing automated equipment, first and foremost.

The equipment under development features a high level of automation and provides high metal removal rates, superior accuracy, and dependability in

operation. The existing equipment is being constantly renovated to increase its production rates 1.3—1.6 times and machining accuracy by 20—30 per cent as compared with machinery produced in the preceding five-year plan period.

Along with the equipment designed to automate manufacturing processes in large-volume and mass production, the output of automated equipment for small-volume production is also growing.

The development of Soviet machine-tool building over the past ten years has been marked by gearing the industry to extensive production of numerically-controlled machines.

The number of NC machine tools manufactured in 1970, 1975 and 1983 was 1,500, 5,500, and 11,400 units, respectively.

In 1983, the share of NC machines in the total output of metalcutting machine tools was 27 per cent, against 12.5 per cent in 1975. 110 new NC models have been brought out over the current five-year period. Numerically-controlled turning, milling, and drilling machines are being fitted out with microprocessor controls having both working and fixed storage. The percentage of multi-operation machine tools with automatic tool changing (machining centres) is being increased along with machine-tool modules which can be put together to form automatic production cells and lines controlled by a central computer. Flexible production systems are being developed.

Many Soviet-built NC machine tools are in great demand on foreign markets. Among them are machines from the Ya. M. Sverdlov machine-tool factory in Leningrad, the 50th Anniversary of the USSR machine-tool production amalgamation in Ivanovo, the machine-tool production amalgamation in Ryazan, and others, which are well known in various countries.

Our industry has amassed a large body of experience in designing and manufacturing unit-built machine tools, which are assembled from modular units and mechanisms. Over 20,000 such machines were produced in 1971—1980. Thousands of Soviet-built automatic and semiautomatic production lines are operated at engineering factories in the USSR.

The manufacture of precision machine tools has been developing vigorously in recent years. The range of types and sizes of precision machinery has been expanding. Jig-boring, jig-grinding, diamond-boring, thread-grinding, gear-grinding, and a variety of special-purpose grinding machines, which are well competitive with similar foreign-built machine tools, are produced in large quantities. Precision and high-precision machine tools now account for 57 per cent of the inventory.

Jig borers, for example, are made in a wide range of types and sizes—from the smallest ones, with a table surface of 160×280 mm to large, double-upright, extra-precision machines with a table surface of 1,400×2,400 mm. The high-precision models are fitted with NC and adaptive systems and in-process control gauges.

A notable technological achievement has been the development of a complex of extra-precision equipment for calibrating the line standards of length and master machine tools of extreme precision. High-precision measuring complexes based on a laser comparator and a micro-computer have been put into production.

The USSR's power, transport, and heavy engineering industries are mainly based on the production equipment put out by our machine-tool manufacturers. The technological and production capacity of Soviet heavy machine-tool building is clearly seen from the dimensional specifications of the machines produced. The range of the available machine tools makes it possible to carry out all known metalworking operations. Our factories make lathes for machining workpieces up to 6 m in diameter and 32 m long; vertical boring and turning mills for workpieces up to 20 m in diameter; hobbers for gears up to 12.5 m in diameter; planers and planomillers with a table width of up to 5 m; large boring machines; and other machine tools. Tens of heavy numerically-controlled machine models are brought out. These machines are used to process components of large steam and gas turbines, casings and crankshafts of powerful diesel engines, nuclear-reactor components, and the like.

Most of the heavy machine tools are designed in the framework of unified machine-tool ranges.

Their high technological standards win steady markets abroad for Soviet machine tools designed to handle large parts. A number of unique machines developed in the Soviet Union perform successfully at industrial enterprises of leading foreign companies.

A good deal of attention is given to the development of electrophysical and electrochemical machining processes. Our industry produces equipment for the electrical-discharge, electrochemical, ultrasonic, laser-beam and other machining methods. The USSR accounts for over 40 per cent in the world production of such equipment.

In recent years, substantial changes have been introduced into the structure of metalforming equipment manufactured at specialized factories of our industry. The content of automated and

mechanized universal metalforming machinery, including automatic complexes, went up from 12 per cent in 1980 to 26 per cent in 1983. Also on the increase is the content of machinery designed for metal-saving processes, such as hot and cold die forging or compacting metal and metal-ceramic powders. The production has been launched of automated complexes based on hot-forging equipment and numerically-controlled metalforming machines.

In casting machinery production, the current five-year plan period stipulates the highest rate of growth for automated equipment. Thus, the manufacture of numerically-controlled casting machines is to rise 1.9 times, automatic lines, 2.3 times, automated equipment for making patterns and cores solidifying in the moulds, more than twice, and automatic manipulators for casting applications, 4 times.

Production of industrial robots has been developing fast in recent years. In 1981—1985, our industry is to expand their manufacture more than sevenfold.

The design of robots is based on the modular principle, whereby specialized equipment intended for solving a specific manufacturing problem, without having redundant capabilities, can be developed. Their functional capabilities, layout, dynamic and accuracy characteristics place our robots on a par with the best foreign counterparts.

The manufacture of new types of metalcutting tools using wear-resistant coatings, non-tungsten cemented carbides, synthetic diamonds, and other superhard materials has developed considerably. The output of cutting tools with indexable cemented-carbide inserts is to grow 1.6 times during the current five-year plan period. The design of indexable-insert single-point tools and inserted-blade milling cutters is being updated. Inserted-blade drills, core-drills, and reamers are being put into production. The manufacture of cutting tools made from non-tungsten cemented carbides will increase 3.8 times, and from

mineral ceramics and superhard synthetic materials, almost twice. More than 50 per cent of all indexable-insert tools is to be produced by 1985 with wear-resistant titanium-carbide and titanium-nitride coats.

The machine-tool building and cutting-tool industry fully satisfies the needs of our economy for abrasive and diamond tools. Production of diamond tools will increase 1.3 times in the current five-year plan period. A line of single-point and abrasive tools for processing titanium and its alloys is being put on stream.

Modern metalworking equipment and tools are developed by tens of research and development institutions, and specialized design and production planning offices.

The Experimental Machine-Tool R & D Institute (ENIMS), called "the brain" of Soviet machine-tool building, is widely known in the USSR and abroad. It determines the lines along which the Soviet machine-tool industry should develop, creates new designs of metalworking machinery, works out new manufacturing processes based on modern scientific and technological achievements, and coordinates the work of other machine-tool design organizations.

The scientific and technological standards of Soviet machine-tool building reflect modern trends of world machine-tool building development to a full extent. The production potential of our industry is sufficient to meet both the requirements of the Soviet engineering industries and export demands.

The export of metalworking equipment (metalcutting and metalforming) expanded by 39.3 per cent during 1975—1982. The export of casting equipment, cutting tools, and abrasives also went up. At present, 90 countries buy Soviet-made metalworking machinery and cutting tools.

The trade marks of such major machine-tool manufacturers as the Krasny Proletary machine-tool factory in Moscow, the heavy machine-tool factory in Kramatorsk, the machine-tool production amalgamation in Ivanovo, the heavy and extra-heavy machine-tool plant in Ulyanovsk, the heavy mechanical press plant in Voronezh and many others, are well familiar abroad.

The economic, scientific and technical co-operation in the machine-tool field between the USSR and many countries is developing extensively.

The co-operation with CMEA member-countries is based on long-term special-purpose programmes of specialization and co-operation of production. These programmes cover about 800 different items: machine tools and automatic production lines, components, units and fixturing. Coordinated work on developing advanced equipment and manufacturing processes, and preparing technical and economic forecasts brings very sizeable benefits. The manufacture of metalworking equipment and industrial robots has increased, and the volume of mutual deliveries has expanded. The CMEA countries and Yugoslavia set up specialized production of a number of components for machine tools made in the USSR. Bulgaria, for example, produces loading/unloading devices and conveyors for automatic transfer lines and hydraulic equipment. Poland specializes in electromagnetic clutches and precision lathe chucks. Centralized production of high-torque motor drive packages is organized in Bulgaria, Poland, Romania, and Czechoslovakia.

Soviet machine-tool builders are also developing contacts with many firms in capitalist countries. Machine-tool manufacturers in Austria, Finland, France, the FRG, Italy, Japan, Sweden, Switzerland, and other countries have been our reliable partners for years. At present, we co-operate in production with 16 West European firms, and similar arrangements are being negotiated with more than 20 other companies. For instance, the Kolonna machine-tool production amalgamation and Schiess (FRG) are, on the basis of a recently signed agreement, developing co-operation on the manufacture of a line of vertical turret lathes and boring mills with a work capacity of 4 to 22 m dia. The Ivanovo machine-tool production amalgamation and Valmet (Finland) co-operate in developing and building flexible manufacturing systems. ENIMS and Festo (Austria) have undertaken a joint programme of research and testing of programmable controllers used for machine-tool control applications. Scientific, technical, and production ties have been established between our factories and several French companies, such as Liné, Constructions de Clichy, Berthiez, Promecam and others.

We highly appreciate the role of such a form of business contacts as international and foreign machine-tool exhibitions in the USSR and take an active part in similar shows abroad.

The scientific and technological potential we have accumulated in the field, the extensive use of achievements of the scientific and technological revolution, and on-going creative endeavour, enable us to solve new and long-range tasks.

INDUSTRY PLANNING AND ECONOMICS

GDR TO INCREASE DELIVERIES OF FMS, SUBSYSTEMS TO USSR

Moscow FOREIGN TRADE in English No 4, Mar 85 pp 19-20

[Article by Dr Rudi Georgi, GDR minister of Machine-Tool and Instrument-Making Industry: "USSR-GDR Cooperation in the Machine-Tool Industry"]

[Text]

Every day the GDR's mass media gives examples of fraternal relations between the Soviet Union and the German Democratic Republic. Now that only several weeks remain before the 40th anniversary of Victory over Hitlerite fascism we can state that our countries' cooperation has progressed and embraces all spheres of social life.

The GDR is a politically stable socialist state with a highly, dynamically developed economy which is constantly augmenting its economic potential.

Soon after the formation of the German Democratic Republic the first Agreement on Trade and Payments between the two countries was signed (April 1950). This Agreement envisaged the USSR's deliveries of machinery, equipment, raw and other materials and also foodstuffs to the GDR. In 1950 the USSR-GDR trade turnover was slightly over 300 million rubles, and in 1984 the mutual trade volume reached 14,000 million rubles.

USSR-GDR cooperation in the machine-tool industry is greatly assisting the development of the countries' trade and economic ties.

Through a stable legal base the two industries' contacts are deepening and expanding. On this point I would like to refer to the USSR-GDR Treaty on Friendship, Cooperation and Mutual Assistance, the Programme for Specialization and Cooperation in Production up to 1990 and also to the Guidelines of Specialization and Cooperation in Production in the machine-tool and instrument-making industry up to 1990. Of great importance also was the signing, in the year of the 35th anniversary of the GDR's formation,

of the USSR-GDR Long-Term Programme of Development of Scientific, Technical and Production Cooperation for the period ending in the year 2000.

In the current five-year plan period cooperation in the above industries is being carried out primarily under inter-departmental agreements, which include design, specialization and cooperation in production as well as mutual deliveries of metal-cutting machine tools, press-forging installations, machines processing plastics and elastomers, etc. Among these agreements is an agreement on cooperation in designing, manufacturing and mutually delivering abrasive materials and instruments made from synthetic diamonds and other superhard materials.

The GDR's machine-tool making complexes' production programmes take into account the demands of various industrial sectors and the Soviet Union's major users. They supply, in particular, certain machines and automatic lines for the bearing, automotive and tractor industries, agricultural machinery and electrical engineering industries. Owing to long-term planning and specialization in production the range of goods and production costs have been reduced to the maximum, materials saved and enterprises' capacities increased. The reduction of the range of products at the same time made it possible to concentrate the research and design potential and design numerous items meeting the higher technical requirements of industry.

*Export structure: a qualitative shift.* The German Democratic Republic is one of the world's largest machine-tool exporters. Over the past 30 years more than 300,000 machine tools with the WMW trade-mark were supplied to approximately 60 countries; over 50 per cent of this number went to the Soviet Union. These figures witness the great significance of the USSR for the GDR's machine-tool industry.

In recent years a noticeable shift has occurred in the structure of the GDR's export to the USSR. At present the GDR supplies the USSR mainly with highly productive special-purpose machine tools, semi-automatic and automatic machine tools and automatic lines. The portion of standard machine tools in the GDR's export to the USSR in 1957 amounted to 75 per cent but in the current year it will be 30 per cent. At the same time the proportion of automated machine tools including those with numerical control will grow from 20 per cent in 1957 up to 50 per cent or more in 1985. Automatic lines and systems today constitute 20 per cent of the export. These deliveries are raising Soviet labour productivity.

The GDR has planned to supply by 1990 nine flexible production systems and 130 flexible production sections for processing housings and rotating parts. When manufacturing this equipment the GDR's machine-tool industry takes into consideration the demands of the USSR—its main purchaser. The first flexible production systems for the Minsk and Gorky factories will be shipped already in the current five-year plan period.

*Mutually beneficial cooperation.* The main task of scientific and technical cooperation between the two countries' industrial associations, complexes and enterprises is to design new machine tools and specialize in production.

We can cite many examples confirming this. Thanks to cooperation between the Ivanovo industrial association and the Fritz Heckert machine-tool complex in Karl-Marx-Stadt new automated boring and slitting machines were designed. Close partnership is maintained also in rationalization of production and exchange of equipment.

Good results were reached also in designing automatic multiposition plate stamping machines, automated press complexes and automatic thermoplastic precision die-casting machines. Our two countries effectively cooperate in designing, manufacturing and mutually supplying abrasive materials and instruments made from synthetic diamonds and other superhard materials. Due to their use labour productivity when processing metal, glass, ceramics, stone and concrete rises.

Cooperation in manufacturing consumer goods and realizing the USSR Food Programme is spreading fast. Thus, the GDR machine-tool industry is participating in reconstructing the Lenin Komsomol Motor Works by supplying highly productive metal-cutting machine tools, press-forging equipment and automatic lines. To increase the production of domestic sewing machines the M. I. Kalinin engineering works in Podolsk will be reconstructed. Deliveries of the GDR's production equipment are envisaged.

Close cooperation with the Soviet Union is seen very well in the GDR's machine-tool industry's exhibits shown at the Leipzig Spring Fair in 1984. Mainly flexible production systems, highly automated processing centres and other items having a high engineering level were displayed. For example, the PASZ250.3-electronic, highly productive automatic two-post cutting machine was exhibited. This machine was designed by the USSR, GDR and Czechoslovakia Joint Design Bureau, and is used for the mass production of electrical engineering products.



USSR-GDR cooperation in the machine-tool and instrument-making industry will deepen and expand. Its further development is based on a recently signed Long-term Programme of Development of Cooperation for the period ending in the year 2000. This document envisages comprehensive mechanization and automatization of major and secondary metal-working processes for the design and manufacture of new types of products corresponding to the world's best standards. The aim is to substantially reduce energy and material consumption and process the existing types of raw material and other materials to the maximum degree.

Along with manufacture and deliveries of equipment for the flexible production sections it is necessary to accelerate the introduction of new progressive technologies such as the laser equipment. Wide application of microelectronics will promote the creation of new unified programme-control systems for machine tools and flexible robotized complexes.

Implementing the Long-term Programme of Development of Cooperation in Science, Technology and Production the Soviet and GDR's machine-tool industries make a ponderable contribution to the further strengthening of our countries' fraternal union.

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## INDUSTRY PLANNING AND ECONOMICS

### CEMA VENTURE TO DEVELOP FMS, ROBOT TECHNOLOGY

#### Scope, Funding of Project

Moscow EKONOMICHESKAYA GAZETA in Russian No 16, Apr 85 p 12

[Excerpts from the "Charter of 'Robot' Association" under the heading "'Robot' International Scientific-Technical Association"]

[Text] The basic tasks and functions of the association include:

- developing the technical concept of developing the robotized complexes and flexible manufacturing systems included in the program;
- determining the national economic requirements of both countries, as well as opportunities for meeting the requirements of third countries, for the indicated complexes and systems;
- preparing proposals on specializing and consolidating the production of robotized complexes and flexible manufacturing systems, as well as on developing specialized capacities in the countries to meet the indicated requirements.

The association is organizing performance of all the work anticipated in the Program, based on agreements (contracts) and is also implementing steps to introduce the results of this work; it is working out and organizing the manufacture and transfer of equipment prototypes; it is working out the technical-economic substantiation and, based on that, recommendations to association members regarding consolidating the production of robotized complexes and flexible manufacturing systems which have been developed and tested; it is developing capacities specialized to manufacture them; it is organizing and implementing technical servicing of the prototype robotized complexes and flexible manufacturing systems and is training specialists to service them.

The association conducts foreign-trade and other types of foreign-economic activity within the limits necessary to carry out effectively the work outlined by the Program.

Membership in the association: Association members are organizations designated by authorized agencies of the countries of the contracting parties which are responsible, in these countries, for implementing the Program. Members have various rights and obligations.

Association funds and financing: A statutory fund is created to provide for the economic activity of the association. The contracting parties share to differing

degrees in creating the fund. The share of the contributions of all association members to any contracting party is equal to the share of contributions of all association members to any other contracting party.

The association performs its activity on the basis of annual and five-year plans drawn up by the Association Council and approved by the Council of Plenipotentiaries. These plans are linked to the state plans of the participating countries. The plans include scientific-research, experimental-design, technological planning, experimental and other work and services performed by the association and based on its orders.

The profits of the association and its branches are distributed among its members in proportion to their proportional contributions to the statutory fund.

Association leadership: Overall leadership of association activity concerning implementation of the Program is exercised by the Council of Plenipotentiaries. (Under the Agreement, the parties form a Council of Plenipotentiaries from among the different numbers of representatives of authorized agencies of the countries of the contracting parties. Each contracting party has one vote in the Council of Plenipotentiaries. The Soviets are led in the Council of Plenipotentiaries by a representative of the USSR State Committee for Science and Technology, the Czechs are led by a representative of the CSSR State Commission for Scientific-Technical and Investment Development; with the concurrence of the corresponding authorized agencies of both parties, the indicated committee and commission determine the composition of the Council of Plenipotentiaries.)

The directing agency of the association is the Association Council, consisting of plenipotentiary representatives of the association members. The plenipotentiary representatives of the association members from the countries of each contracting party each have one vote in the Association Council.

Day-to-day leadership for the economic activity of the association is effected by the general director, the general designer.

The financial activity of the association is monitored by an Auditing Commission designated by the Association Council.

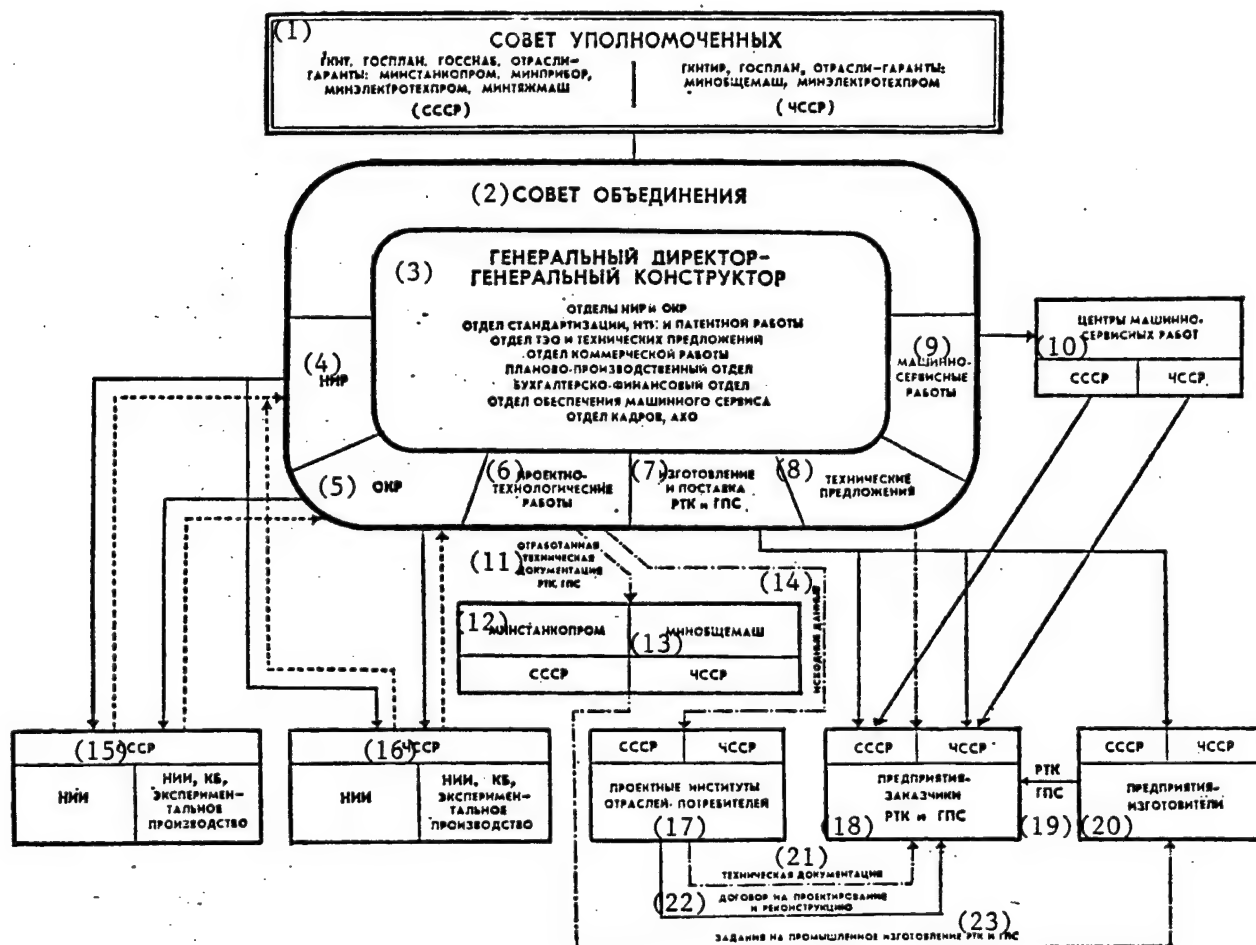
#### Bal'mont on Organization, Cooperation

Moscow EKONOMICHESKAYA GAZETA in Russian No 16, Apr 85 p 13

[Article by B. V. Bal'mont, USSR minister of Machine Tool and Tool Building Industry]

[Text] A special role has been given the Minstankoprom (Ministry of Machine Tool and Tool Building Industry) in our country in the development of comprehensive automation of production processes on the basis of flexible technology. It has been entrusted with the duty of implementing a unified technical policy in the field of creating, manufacturing, introducing and servicing flexible manufacturing systems at machinebuilding and metalworking enterprises. This year, enterprises of the Minstankoprom will manufacture more than 4,000 industrial robots, and the creation of 15 flexible manufacturing systems is anticipated.

Functional Chart of the 'Robot' MNTO [International Scientific-Technical Association]



Key:

1. Council of Plenipotentiaries:
  - [left] USSR: State Committee for Science and Technology, Gosplan, Gossnab, guarantor branches: machine tool and tool building industry, instrument making, automation equipment and control systems, heavy and transport machine-building.
  - [right] CSSR: State Commission for Scientific-Technical and Investment Development, guarantor branches: general machine-building, electrical equipment industry.
2. Association Council
3. General Director - General Designer:
  - scientific research and experimental design departments
  - standardization, scientific-technical information and patent departments

- commercial department
- production planning department
- accounting-financial department
- machine service department
- personnel and administrative department
- 4. Scientific research
- 5. Experimental design
- 6. Technological Planning
- 7. Manufacturing and delivering robot-technological complexes and flexible manufacturing systems
- 8. Technical proposals
- 9. Machine service
- 10. Machine service centers (left: USSR; right: CSSR)
- 11. Finished robot-technical complex and flexible manufacturing system documentation
- 12. USSR Ministry of Machine Tool and Tool Building Industry
- 13. CSSR Ministry of General Machinebuilding
- 14. Initial data
- 15. USSR (left: scientific research institutes)  
(right: scientific research institutes, design bureaus, experimental production)
- 16. CSSR [as in 15]
- 17. USSR/CSSR: consumer-branch planning institutes
- 18. USSR/CSSR: customer enterprises for robot-technical complexes and flexible manufacturing systems
- 19. (above:) robot-technical complexes  
(below:) flexible manufacturing systems
- 20. USSR/CSSR: manufacturing enterprises
- 21. Technical documentation
- 22. Planning and renovation agreement
- 23. Industrial manufacturing assignment for robot-technical complexes and flexible manufacturing systems

For example, early this year, the Krasnyy proletariy [Red Proletariat] plant in Moscow started up a large flexible automated production facility to manufacture industrial robots for use in the NPC lathes being produced by that enterprise. Krasnyy proletariy workers have set themselves the task of manufacturing upwards of 2,000 flexible production modules for turning by the end of the year.

Cooperation with CEMA member-nations is beginning to make a tangible contribution of resolving the tasks of comprehensively automating production processes on a base of flexible technology.

Interaction in this field, and with Czechoslovakia in particular, was begun more than eight years ago and has led to the development of a number of industrial robots to serve forge-press equipment, die-casting machines and metal-cutting machine tools. Their series production has now been mastered both in the USSR and in the CSSR. Work is underway to develop industrial robots to automate welding and prefabricated assembly work.

Jointly with our colleagues from the CSSR, using equipment already introduced, we have developed a number of robot-equipment complex models based on equipment series produced in our countries and delivered reciprocally. Their analogs are operating successfully at various domestic enterprises (the Dinamo plant in Moscow, the Ministry of Electrical Equipment Industry's plant imeni S. M. Kirov, the Lipetsk machine tool plant of the Minstankoprom, the Khartsyzskiy turbine plant of the Ministry of Ferrous Metallurgy and others), as well as at a number of plants in the CSSR, for instance, a Bardeyov plant manufacturing crankshafts.

With a view towards further developing work on robot equipment and developing prototypes of robot equipment, an agreement was signed on 29 November 1983 to create a joint Soviet-Czechoslovak planning design bureau (PKTB), named "Robot," as one of the first temporary international CEMA collectives to develop promising types of automated equipment. And although only a year and a half has passed since then, its results have been appreciable. Technical plans and working documentation have been developed for a flexible production line to process heavy shafts weighing up to 160 kg for the Ministry of Railways' locomotive repair plant in Velikolurskiy and a flexible automated line for sheet-stamping parts weighing up to a kilogram. A list of automated-assembly items, including seven consumer items (the Malysh vibropump, Vesna tape recorder tape transport mechanism subassemblies, and others) has been prepared and agreed to.

We will soon be releasing a products list, a catalog of robotized technological complexes being created in both countries on the basis of equipment and industrial robots subject to reciprocal delivery. This material is a document which will permit long-range planning of reciprocal deliveries of the indicated equipment.

At the same time, the acceleration of scientific-technical progress demands further improvement in the economic and scientific-technical integration of CEMA countries, the practical embodiment of a complex of measures which comprises the unified "science - production - marketing" goal.

One organizational form of such cooperation is the "Robot" International Scientific-Technical Association, whose charter anticipates the possibility of other interested CEMA countries' joining it.

Successful cooperation in the development of advanced technology by the USSR and the CSSR is being implemented, as we know, not only between them, but also with other fraternal countries of socialism.

Our country maintains good, long-standing ties with Bulgaria in the area of developing and using industrial robots. The Pirin gantry robots, used to service metal-cutting machine tools on automated lines, are well known at domestic enterprises in automotive, tractor and other branches of industry. The RB-211 painting robots made in Bulgaria are operating successfully at [our] plants. Bulgarian and Russian scientists recently created the promising RB-251 robot for arc welding.

The machine-tool manufacturing branch is cooperating fruitfully with Bulgarian colleagues. They have jointly developed the RB-112 industrial robot to service

automated lines consisting of unitized machine tools. The Krasnyy proletariy plant in Moscow, with the assistance of Bulgarian colleagues, is mastering the series production of M10P and M20P robots to service a broad range of metal-cutting machine tools. Joint testing has been done on a number of Bulgarian models for servicing metal-cutting machine tools (RB-231) and forge-press equipment (RB-110), and ways to further improve them have been outlined.

Specifications and lay-outs for creating robot-equipment complexes to machining based on GDR DFS machine tools and USSR M40P and UM-160 industrial robots developed jointly with the CSSR and robot-equipment complexes based on presses and industrial robots with load capacities of 1.25 kg have been developed and agreed to within the framework of bilateral ties with the GDR.

Multilateral cooperation is being developed successfully to create agreed-to normative-technical materials, and information is being exchanged in the area of creating very important robot equipment and flexible production system assembly components; work is underway to test industrial robots and work out common directions in which to continue improving them. A broad range of normative-technical documents has been developed in the field of robot engineering. All CEMA member-nations are participating in this work.

At present, the CEMA Committee for Cooperation in the Field of Machinebuilding has worked out a General Agreement on the Creation, Production and Introduction of Flexible Manufacturing Systems. This document will become the basis for further development of mutually advantageous CEMA cooperation in the area of comprehensively automating production processes on the basis of flexible technology.

11052

CSO: 1823/118

## METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

### AUTOMATION OF ROTARY-TABLE MILL GF-1770 DETAILED

Moscow MASHINOSTROITEL' in Russian No 10, Oct 84 p 11

[Article by V.A. Dotsenko, A.I. Filippov: "Automation of a rotary-table mill"]

[Text] The Zhdanovsk branch of the "Pochvomash" Design, Construction of Technical Institute has designed automation of the GF-1770 rotary-table mill for simultaneous bilateral milling of facing cams in cylindrically-sleeved parts.

The automation of a rotary-table cutting mill includes a 24-seat blank-working attachment mounted on a rotary table, a two-spindle mill head (11) rigidly attached to a spindle head, an automatic loader consisting of a magazine (18) and tilted trough (22), a mechanism (16) for drawing parts (21), unloader (3), a burr-grinder (8) and pneumatic cock (23) for controlling the work of the unloader.

Slots for the placement of machined parts (21) are radially distributed along the body of the seat attachment and the lower plate (29) contains pneumatic cylinders with pistons (30) and a piston rod (31) that act with the roller (27) and catch (26). The pneumatic cylinders are connected by lines to a central distributor valve that automatically feeds compressed air for rotation of the table.

The two-spindle milling head (11) (patent number 848184) regulates spacing (the head design is described in MASHINOSTROITEL', 1981, No 5, p 35). In the spindles of the milling head, three-sided disc cutters (13) with solid-welded cutters are attached to mandrels. The head's spindles turn in different directions. The magazine (18) with blanks is mounted on a base (20) and is fastened with clamps (19). It has a series of vertical channels for blanks and a hinged strip (17). The lower tilted trough is placed on the same plane as the trough (22) with loading window (24) rigidly fastened to the base (20). The magazine's vertical channels have a shut-off device (not shown in figure) which automatically removes blanks from the next channel once they are released from the preceding channel. The housing of the device (16) for drawing blanks against the base props (14) is rigidly attached to the base (20). The spring-fed thrust journal (15) of the drawing mechanism moves along guides.

The pneumatic cylinder (1) of the discharge mechanism (3) is rigidly attached to a bracket. The cylinder piston rod (2) is hinged by a special screw to a grip housing (25) which moves along guides (4) and has a spring-fed grip (5) on its axis.

The burr-grinder (8) consists of an electrical motor (10) and head (9). Mechanical wire brushes (7) are attached to the head of the burr-grinder. The pneumatic cock (23) has a spring-loaded cylindrical valve with a roller that acts with the cams (6) of the blank-working attachment.

Before work is begun, the magazine with blanks is clamped to the base (20). The rotary table (12) and attachment begin to continuously rotate the spindles and head (11) with cutters (13). The two-spindle head (9) with mechanical brushes (7) also begins to continuously rotate.

By turning the hinged strip (17) from the first vertical channel of the magazine, the parts move under their own weight along the tilted trough (22) into the vertical loading window (24) and drop singly into the seats. The upper surface of the attachment body serves to cut off the flow of blanks in the window (24). Turning counterclockwise, the rotary table and attachment move a blank toward the drawing mechanism which then presses it against the base prop. When the part approaches the milling head, compressed air from the distributor is automatically fed through a channel (28) into the piston which forces the piston and clinoform piston rod up to press the part against the catch (26). The blank is then milled simultaneously on both sides by four cutters.

When the worked part reaches the two-spindle head (9), the burrs on both of its faces are simultaneously ground by mechanical brushes (7). As the table continues turning, compressed air is automatically fed into the piston of the pneumatic cylinder and the piston with the piston rod drops down so that the channel (28) opens to the outside atmosphere. The part is freed when a spring forces the catch away from it.

Before the part reaches the unloader (3), the tilted surface of the intermediate cam of the attachment presses against the roller of the pneumatic cock and compressed air from the system enters the piston chamber of the pneumatic cylinder (1). The rod (2) then moves the grip housing (25) and the grip (5) along the radius to the axis of the rotary table. When the roller of the pneumatic cock (23) leaves the master cam, compressed air is fed into the piston chamber of the cylinder (1) and the piston and grip move in the opposite direction. The discharge mechanism's grip then casts the finished part into a tilted trough beneath it which moves the part into a container.

When an empty seat reaches the loading window, the next blank drops into it and the cycle is repeated.

Every blank of all 24 seats of the attachment go through this cycle. The process of loading, working and discharge is automatic. The operator only changes magazines using a lift.

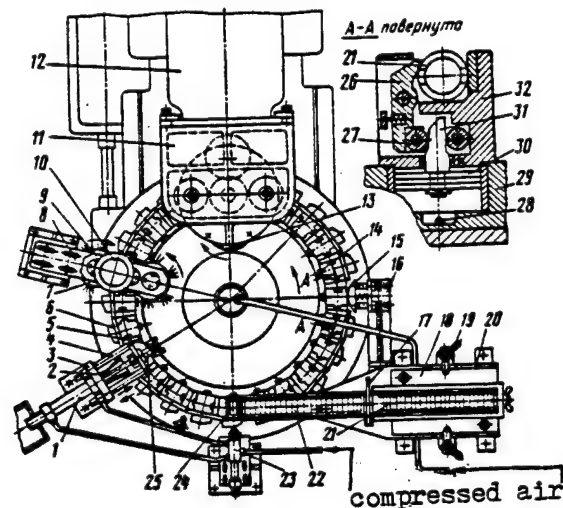


## Technical Characteristics

Output, units/hr.....	250
Magazine capacity, units.....	14
Pressing force of air compressed at 4 kg/cm <sup>2</sup> .....	1350
Power of the electrical motor for the grinding head, kW.....	1.0
Weight of machinery (minus mill weight), kg.....	2190

The same mill can be used to cut grooves into mated parts simultaneously from both sides. Changeable mandrels and cutters allow quick readjustment of the system.

Automatic milling of facing cams on this rotary-table mill can produce a savings of about 17,000 rubles.



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CSO: 1823/131

## OTHER METALWORKING EQUIPMENT

### UNCERTAIN FUTURE FOR ROTARY TRANSFER MACHINES

Moscow SOVETSKAYA ROSSIYA in Russian 22 Mar 85 p 3

[Interview with Lev Nikolayevich Koshkin by A. Pankov: "The Philosophy of Technology: What Experience Tells Us--What Rotor Lines Provide;" under the rubric: "Polemics, Dialogues, Opinions." Time and place not specified]

[Excerpts] A piece of metal or any other material is loaded into a machine and a completely finished part comes out. Who has not dreamed about such a technology? Productivity is sharply increased and people are freed from having to perform manual operations. One means of automating production is the use of rotary and rotary transfer lines. The problems connected with their use was discussed in September of last year at a session of the CPSU Central Committee Politburo. The essence and advantages of these lines, how they were created and what has hindered their wide introduction to industry is the subject of today's interview with the creator of rotary technology, L. N. Koshkin. During the first five-year period, he began his career as a worker and forty years ago he organized and directed the design bureau at which the first rotary lines were developed. Lev Nikolayevich is a member of the Academy of Sciences and the USSR and VASKHNIL [Lenin All Union Academy of Agricultural Sciences], a Hero of Socialist Labor, a recipient of the USSR Lenin and State Prizes and meritorious inventor of the USSR.

[Question] This is the entire philosophy of modern technology...But what are rotary lines?

[Answer] Working elements and instruments are arranged on a continuously turning disc or rotor. The rotor also handles blanks and work is performed as it turns. This is similar to the automated bottling of fluids. As it is machined, the part is passed automatically passed from one machining tool to the next. Rotary lines of any size can be formed from individual machine tools.

On the new generation of rotary transfer lines, any number of instruments can be placed on a conveyor line.

The capacity of such lines is not limited by the duration of operations and this is what makes it possible to combine them so.

[Question] What advantages does rotary transfer equipment have over other types of automation?

[Answer] The overall productivity of rotary transfer lines is ten times greater than that of the best conventional automated machine tools! Structurally, they are relatively simple, easy to operate, reliable and accurate. They can turn out machine parts of any shape. The use of such lines makes production much more economical. It costs about 5000 rubles to replace one worker but this cost is recovered in one to two years.

[Question] Some specialists feel that the use of rotary transfer lines is limited by their "rigidity", that is, that it is impossible to quickly reset them for the manufacture of new items of different size or shape. They claim that the entire line must be reconstructed before a new item can be produced.

[Answer] It is totally untrue that these lines cannot be adjusted. Discard an entire line? This shows the concept behind traditional methods of work. Of course you do not have to build a new line for each item produced but for every type of item or set of operations. For example, a line can be set up to produce shafts and the component instruments of the line are changed to produce shafts of different sizes.

[Question] This is still one disadvantage that the specialists have pointed out. Rotary lines are not designed for cutting operations.

[Answer] Actually, they are more widely used for stamping, casting and metalworking but they can be used to cut metal too. However, the most progressive and economical methods, the methods of the future, do not involve cutting but stamping, pressing, casting, powder spraying, etc. In view of present-day technology, one can no longer say that our machines have any such "shortcomings". We must look into the future.

Aside from this, No cutting operations at all are used in so many branches of industry such as brickmaking, the manufacture of light bulbs, baking, the processing of meat, dairy products, fish and confections and in light industries and textiles! And everywhere, rotary transfer lines are being used for mass production. We have estimated that if rotary technology is used in these industries alone, millions of workers would be freed.

[Question] Lev Nikolayevich, at the end of last year, a general session of the Academy of Sciences of the USSR elected you as a member of the newly-created Division of Data-Processing, Computer Technology and Automation. We congratulate you...Your election was quite logical. For several years, however, you have already been a member of VASKHNIL. What connections do you have with agriculture?

[Answer] I proved that it was necessary to use new types of machinery for working immovable objects such as soils and plants.....Our present machinery

has become obsolete. It is too slow. Its productivity has been improved by increasing the reach and span but this has also increased its weight, which is harmful to the soil being cultivated and the cost of such equipment is too high.

We suggested the use of the rotary principle which allows a machine to move over a field much faster at any duration of contact between the instrument and soil. They have begun to develop a potato harvester, cultivator and machinery for use in livestock shelters...

[Question] Does this mean that rotary machinery can be used for more than metalworking?

[Answer] Yes. With our help (and sometimes even entirely independently) rotary lines have come into use in the most diverse industries such as the Karbolit Plant in Orekhovo-Zuyevsk, a meat-packing plant and battery factory in Podolsk, a ball-bearing plant in Saratov, the Tula Agricultural Machinery Plant, and for assembly of aerosol valves in Riga.

[Question] Despite its advantages and long years of proven usefulness, rotary technology has still not become as widely used as possible. This was discussed at the Central Committee Politburo session in September of last year. Why, in your opinion, has its introduction been so slow?

[Answer] I am not even scratching the surface of the problem if I say that it is the result of inertia, fear of taking responsibility (and if the new device does not turn out well?) and narrow institutional interests. Finally, anything new must always prove itself. The efforts of one person do not amount to much in the introduction of new technology because the help of branch research and development institutions and design bureaus is also necessary. However, every collective has already planned its own type of line. They defend their own ideas and do not need those of others. A collective does not gain any advantages from using someone else's ideas.

We must more quickly and boldly change our criteria for evaluating the activity of plants and more strongly stimulate the introduction of new technology and the production of new models. Introduction of this new technology faces must deal with the simple question of which factory director receives higher wages. The answer is quite clear: the factory that has more workers. And if the factory becomes automated?

The work of scientists, engineers, inventors to introduce finished designs is weakly stimulated. They introduced one automated line and then another. And in the case of the latter, its effectiveness was evaluated by comparing it with the former. Is this correct? If there is no analogy, the economists generally refuse to determine a system's effectiveness. Why do they not consider the cost of using imported equipment?

The pay-back period for investment to stimulate the introduction of new technology is three years. But cannot much be accomplished in three years? In this series, serious work comes later. And that makes it necessary to work

on trifling projects that produce a quicker result while any profoundly new direction is given less and less attention.

[Question] Lev Nikolayevich, scientists and designers now face the problem of creating a technology equal to present world standards. What, in your opinion, prevents them from attaining this level of technology?

[Answer] What great things could be achieved by design bureaus if they did not try to climb a ladder to the moon? They spend years calculating the durability of structures, they have looked for the most reliable materials, theorized, defended dissertations and built improved ladders...You laugh but there are many design bureaus and institutes that work in this way for years without coming up with anything new. They work on minute improvements to old and obsolete technology. Of course, you can achieve something even with this approach but it cannot solve the key problems of the scientific and technological revolution.

With regard to the attainment of a high level of technology I would say that the problem has, in essence, been correctly formulated but it is in most cases too often understood too linearly: famous foreign achievements are copied. This is a fallacious practice. First of all, the ideal of attaining the world level of technology is not so far from us in all areas. Second, our foreign colleagues will not remain idle while we strive to catch up with them. This means that if we are not to stay where we are, we must work to go beyond the famous advanced ideas of our times.

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CSO: 1823/125

OTHER METALWORKING EQUIPMENT

"SIBIR'-3 M" FORGING HAMMER REDUCES METAL WASTE

Moscow SOVETSKAYA ROSSIYA in Russian 23 May 85 p 1

[Text] Novosibirsk--The "Sibir'-3 M" forging hammer can work high-strength metals and alloys by the forging method. Yesterday, the "Tyazhstankogidropress" (heavy machine tool and hydraulic press) Association imeni Yefremov completed shipment of the technological innovation to its customer, the Moscow Test Plant of Refractory Metals and Hard Alloys.

The machine-tool builders developed the powerful, high-speed forging hammer jointly with the Special Design Bureau of Hydraulic-Pulse Technology of the USSR Academy of Sciences' Siberian Branch. Deformation of the hot billet in the die takes place in thousandths of a second. Such speed makes it possible to produce forged pieces of complex configuration with minimum allowances. As a result, metal waste is reduced to one-fourth.

FTD/SNAP  
CSO: 1823/145

OVER 50 FLEXIBLE MANUFACTURING SYSTEMS REPORTEDLY OPERATING

Moscow EKONOMICHESKAYA GAZETA in Russian No 22, May 85 p 2

[Unsigned article under rubric "Technical-Economic Review": "Flexible Automated Facilities"; passages enclosed in slantlines printed in boldface]

[Text] The scale and nature of the problems facing the machine-building industry require profound changes in its production and technical base. The resolution of the CPSU Central Committee and the USSR Council of Ministers, "On Measures to Accelerate Scientific and Technical Progress in the National Economy," stresses the importance of extensive automation of manufacturing processes on the basis of automatic machine tools, standard equipment modules, robotic systems and computerization.

Automation of the main manufacturing processes in mass production, with the exception of assembly jobs, has attained a comparatively high level. However, the successfully employed lines and automatic machine tools are designed for machining a very restricted range of output, thereby restraining the rate of renovation of manufactured products and in some cases becoming an obstacle to technological progress.

Furthermore, experts estimate that mass production accounts for only one-quarter of all machine-building output. The other 75 percent of products are manufactured in series, small series, or custom-made, and the level of automation is considerably lower. Moreover, an analysis of the trends in world machine building indicates that the importance of small-series production will continue to grow owing to the continuous increase in the product range and constant changes in machine designs and parameters.

These considerations give rise to fundamentally new requirements. As was noted at the April, 1985, plenum of the CPSU Central Committee, revolutionary changes are needed, involving conversion to fundamentally new manufacturing systems and new-generation machinery providing the greatest effectiveness.

/Flexibility and mobility are the main directions for upgrading all types of machine building, from mass to custom-made./

The latest scientific and technical achievements in the spheres of automation, electronics, microprocessors, robotics, and various types of program-controlled equipment have opened up opportunities for the practical realization

of these requirements. The question is of developing fundamentally new means of production in machine building: flexible manufacturing systems.

The state standard defines a flexible manufacturing system as "an aggregate or individual item of technological equipment and the systems for maintaining its operation in an automatic mode, possessing the capability of automated readjustment in the manufacture of items of a random product range within set specifications." Organizationally, flexible manufacturing systems are classified in four levels: flexible manufacturing modules, flexible automated lines or sections, flexible automated shops, and finally, flexible automated plants.

The basis of all types of flexible manufacturing systems is the flexible manufacturing module, which is a self-contained, program-controlled unit of equipment with the means for automating a manufacturing process: storage units, loading, unloading, tool and accessories replacement, and scrap removal devices, and automatic control and diagnosis instruments. A flexible manufacturing module may also be a robotic complex, if its design and layout permits it to be built into a higher-level system.

A flexible manufacturing system can include various subsystems, e.g., for automated design and technological preparation of production, transportation and storage, tool supplies and maintenance, or a central computerized control system. Automated systems for the technological preparation of production ensure, in particular, the automated preparation of control programs for the basic manufacturing equipment. Transportation and storage systems are designed for rapid storage and delivery of blanks, tools and accessories to work stations and removal of shavings and scrap. All flexible manufacturing systems components operating in the automated mode are subjected to the highest technical requirements.

For example, the storage facilities of flexible manufacturing systems should be at least equal to, or even superior than, the corresponding specifications of the basic manufacturing units in equipment, rigidity, dependability, and even external appearance. The reason is that a storage unit is not just a place for storing items: it also performs sorting and distribution operations closely linked with the manufacturing process. A malfunction in the operation of the storage unit, which is the initiating manufacturing element, can bring the whole system to a halt. All this applies fully to automatic, program-controlled industrial trucks, such as battery-powered robot trucks and other devices.

Work on the development of flexible manufacturing systems has been going on in our country since the early 70s. Currently there are more than 50 flexible manufacturing systems for a variety of processes.

/Currently operating flexible manufacturing systems produce a wide range of parts, in some cases spanning up to 250 and more items./

Most flexible manufacturing systems are designed mainly for machining complex machine housing parts. One system may include up to several dozen machine tools. An example is the Talka-500 flexible manufacturing system designed for small-series machining of up to 100 housing parts, which was built by, and



installed at, the Ivanovo Machine-Tool Building Production Association imeni 50-letiya SSSR. All processes, from receiving the blanks to shipping the parts, are performed in the automatic mode by computer control.

The Talka system includes the following sections: manufacturing, production startup and finished products, and control.

The manufacturing section consists of four Modul'-500 machining centers, one IR800MF4 center, and a transport system linking the machine tools with the production startup and finished products section. The machines are equipped with devices for automatic tool and table change as well as with eight-item storage units for the tables.

The transport system consists of a rail truck with a table transfer device that moves along the storage units, four table-loading stations, and two tool loading-unloading stations. It delivers the blanks to the machine tools, returns the machined parts and freed tables to the station, delivers sets of tools in special devices to their positions, and automatically loads the tool magazines.

The production startup and finished products section consists of an automated storage unit with a stacker, roller conveyers for moving blanks and tables, stands for assembling locating elements on the tables, and auxilliary equipment.

The experience acquired in operating this and other Soviet-made and foreign flexible manufacturing systems shows that they make it possible to increase the productivity of numerically controlled machine tools on average 1.5- to 2-fold over the aggregate productivity of the same number of individually operating program-controlled machines. A consequence of this is a substantial (40 to 60 percent) reduction of the manufacturing cycle and the corresponding volume of uncompleted production and the elimination of human-operator jobs.

In May 1984, the USSR Council of Ministers passed a decree "On Accelerating the Automation of Machine Building on the Basis of State-of-the-Art Manufacturing Processes and Flexible Readjustable Systems."

/It is planned to manufacture and place in operation more than 30,000 flexible manufacturing modules for various technological processes and more than 1,800 flexible manufacturing systems./

In the course of the 12th 5-Year Plan, the inventory of numerically controlled machine tools is expected to more than double. More than 100,000 industrial robots will be built.

Experimental demonstration flexible manufacturing sections and shops are being set up in all branches of machine building. The leading ministries have been designated for developing the respective types of equipment and parts of flexible manufacturing systems.

In all of this a special role is assigned to the Ministry of the Machine Tool and Tool Building Industry, which has been tasked with the duty of implement-

ing a unified technological policy in the development, manufacture, introduction and maintenance of flexible manufacturing systems at machine-building and metal-processing plants. The machine builders have actively begun to implement the tasks stipulated in the decree.

This year plants of the Ministry of the Machine Tool and Tool Building Industry alone will build more than 14,500 numerically controlled machine tools, including 1,550 machining centers, no less than 600 numerically controlled units of press-forging plant, 7,000 press-forging machines equipped with mechanization and automation devices, and more than 4,000 industrial robots. The Ministry's plan for 1985 provides for the development of 15 flexible manufacturing systems.

At the beginning of this year the Moscow Krasnyy Proletariy Plant put into operation a large flexible automated facility for the manufacture of industrial robots which will be used to equip numerically controlled lathes built by the plant. The plant workers have set themselves the task of producing more than 1,500 flexible manufacturing modules for lathes.

/The design, manufacture, and introduction of flexible manufacturing systems requires a new type of relationship between consumers, developers and manufacturers./

The role of the customer ordering a flexible manufacturing system increases immeasurably. He must thoroughly consider and clearly define the specific production objectives for developing such complex and expensive equipment, the range of machined items, the ways of assuring capacity operation of the system, and how it fits into the other production facilities of the plant. Equally important is the timely training of skilled personnel for the maintenance of flexible manufacturing systems: technicians, computer mechanics, operators, adjusters, maintenance personnel.

The developers and manufacturers must ensure a much higher level of dependability of all elements and of the system as a whole, as well as qualified, timely servicing. The development of flexible manufacturing systems requires the coordinated efforts of many organizations and plants. Accordingly, greater responsibility is placed on the chief designers of flexible manufacturing systems and their components appointed in each branch of machine building. Success can be assured only if the customers and developers of flexible manufacturing systems take equally responsible and equally concerned attitudes.

The development and introduction of flexible manufacturing systems must be preceded by serious technical and economical analysis and justification. It is important to assess in advance the costs of the system, quality of its elements, and organization of appropriate operating conditions. Otherwise the use of such complex and expensive machinery may prove to be a burden for the plant's business and result in a decline in the capital-output ratio. That is just what happened at the Sasovo Machine Tool Association, where an automated section of numerically controlled machine tools for manufacturing body-of-revolution type parts had a workload for virtually only one shift.

Various branches of the machine-building industry are engaged in the development and perfection of flexible manufacturing systems. Modules capable of operating without, or with limited, involvement of human operators are being developed. This holds the promise of raising labor productivity in different operations four- to eight-fold. Laboratories are working on the incorporation in flexible manufacturing systems of lasers for measuring and manufacturing, new methods of automatic diagnosis and adjustment, and the use of waste-free technologies.

The introduction and efficient use of flexible automated systems and the organization of integrated production facilities on their basis will create real opportunities for the machine builders to sharply increase labor productivity, not just be a few percentage points, but many times over.

9681

CSO: 1823/144

AUTOMATED LINES AND AGREGATED MACHINING SYSTEMS

BRIEFS

AUTOMATED GEAR MACHINING SYSTEM—Lithuanian SSR (TASS)—The Kaunas Machine-Tool Building Association imeni Dzerzhinskiy has introduced many state-of-the-art technologies and modern equipment. One of the latest innovations is a fully automated system for machining gears and jaw clutches developed and introduced in collaboration with experts from the Litstankoprojekt [Lithuanian machine-tool design] Scientific-Production Association. Workpieces are transported and mounted with the help of automated lines and robot manipulators. Photo shows general view of automated system [photo not reproduced]. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 22, May 85 p 2] 9681

BARANOVICHI AUTOMATION PLANT FEATURED—Belorussian SSR (TASS)—Workers of the Baranovichi Transfer Line Plant are vigorously implementing their pre-congress pledges. In four months the plant has produced a million rubles' worth of highly productive state-of-the-art equipment over and above the assignment. It has fully met all contractual deliveries. The growth rate of labor productivity was almost seven percent instead of the planned four percent. The photo shows a transfer line being built for the Aksaykardandetal' Plant [photo not reproduced]. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 22, May 85 p 2] 9681

CSO: 1823/144

## ROBOTICS

### CEMA COOPERATION IN DEVELOPMENT OF ROBOTICS, FMS VIEWED

Moscow MASHINOSTROITEL' in Russian No 3, Mar 85 pp 40-42

[Article by A.M. Kostin, and M.K. Uskov, candidates of technical sciences: "Robotics: the experience of the socialist countries"]

[Text] The first two issue of MASHINOSTROYENIYE are a clear example of the creative partnership shared in robotics and FMS research by the CEMA nations.

The first edition contained articles by CEMA-nation authors on current problems in the development of robotics in the socialist countries, its testing, diagnosis and use of industrial robots, designing robot control systems, and training and retraining engineering personnel specialized in robotics. Aside from this, the articles throw much light on the problems of standardizing and unifying items of transport machinery jointly produced by CEMA countries, cooperation in the electronics industry within "Interelektro" as well as other machine-building problems.

Members of the CEMA Secretariat, Technical Sciences Candidates V.A. Prokudin and K.I. Shvedov examined in their article the strategy of scientific, technical and industrial cooperation between the CEMA nations in the area of comprehensive mechanization and automation of industrial processes. At the present time, the necessary prerequisite conditions for extensive development of robotics in these countries have been established: many of these countries have formed national programs for development of this technology and for several years, these same countries have already conducted joint research. Thus, in 1980, a series of agreements on scientific and technological cooperation and production in the field of robotics were signed. The CEMA plans for robotics research included joint integrated work for the years 1981 to 1985. In accordance with the work undertaken for this long-term program, robot-manipulators were created for metal-cutters, forging and pressing machinery, casting equipment and especially for technological operations such as welding, assembly, dying, etc.

At the 34th CEMA congress in 1982, a general agreement was signed on cooperation between member nations on the development and organization of specialized and cooperative production of industrial robots. As a result of this agreement, the Council of Chief Designers was established and become the main coordinators for work in this area. The council called for robotics

research in which one of the chief means of introducing industrial robots is to be their use within technological complexes.

In the opinion of the authors, the most important goal is the building of FMS and this should be the object of modern research. Considering the problems associated with this, the authors have given special attention to the economic aspects of developing and introducing adjustable automated production (dimensions of production and its specialization) and the role of structural and technological study of documentation before production is started.

In conclusion, V.A. Prokudin and K.I. Shvedov stated that the development of a cooperative program in robotics also requires the formulation of a long-term program for the training of workers, engineers and specialists in accordance with the given strategy for cooperation.

The problems of cooperation between CEMA nations in the field of machine building were examined in an article by CEMA Secretariat Colleague R.A. Lavrov. He mentioned the role of the Permanent CEMA Commission For Cooperative Machine Building in the organization of joint economic and scientific-technological cooperation between CEMA nations. His article examined the joint agreement signed by these nations on specialization and cooperation in the production of various types of equipment and machinery and examples of cooperation in machine building between nonmember nations such as Yugoslavia and Finland were described.

USSR Academy of Sciences Member K.V. Frolov analyzed current problems in research on machine building with special attention to the important place taken in the re-equipment of the machine-building industry by robotic systems.

The passage of time has made it necessary to use new and improved types of robots. Modern robots should be equipped with a system that can sense the state of the environment and properties of production objects manipulated by the robots and process data. Gathering and processing such data, a robot can use it to realize a given program. This has led to great possibilities for automating different operations and such robotic systems have been found to be useful to bring together different technological operations into a single automated system of production.

The resolution of these problems requires the preparation of programs that to a large degree depend on the "sensitivity" of the robot. Work in this area has been conducted by many organizations including the USSR Academy of Sciences' Institute of Mechanical Engineering imeni A.A. Blagonravov. In accordance with the basic directions for the economic and social development of the USSR for 1981-1985 and the period leading up to 1990, this work is to be broadened. This will make it possible to specialize automated machinery designed for the specialized manufacture, replace general-purpose equipment with with NC tools. The creation of such robotic systems makes it possible not only to considerably improve productivity but also to solve a problem of greater social importance -- to eliminate manual labor, especially under harsh and dangerous conditions.

A. Angelov and N. Shivarov, robotic specialists and correspondent members of the Bulgarian Academy of Sciences, examined the problems of robotics research in the Bulgarian People's Republic.

The practical beginning of robotics research in the Bulgarian people's Republic was closely connected with Soviet industry. At the Institute of Metal-Cutting Tools (Sofiya), the first "Pirin" Bulgarian-manufactured industrial manipulators designed to service metal-cutting tools were created. These industrial manipulators were also some of the first to be introduced to Soviet machine-building plants.

Since 1981, Hungary has intensively broadened its research and design work to develop third-generation Hungarian robots. This country has produced a two-handed robot with stereoscopic television cameras that allow it to recognize the relative position of objects in a three-dimensional space. laser-optical sensors for accurate orientation of objects and many other original devices. Aside from this, Hungary has also developed an extensive program for the introduction of industrial manipulators and robots in various branches of industry. At the present time, the production of industrial robots and manipulators in Hungary has been based on two aspects: the satisfaction of certain of its own unique needs and for export within international cooperation.

In his article, A. Rot (Hungary) reports that in the process of robotics research, it has become necessary to create and use manipulators and industrial robots that can be programmed to move objects and therefore replace human labor. It has also become necessary to build technological robots that can replace workers in certain monotonous or dangerous production processes such as point and line welding, painting and enameling, removal of hot casting forms and recently even assembly work.

In comparison with traditional single-purpose automation, industrial robots have made it possible to automate small-lot production thanks to switch over from one type of robot to another during operations and quickly readjust production if the task is changed. Industrial robots can follow changes in the structure of production and fluctuations in the assigned volume of production, do not tire during monotonous work and are therefore not subject to any of the defects, inaccuracies or breakdowns caused by human fatigue. The introduction of industrial robots eliminates accidents and professional difficulties resulting from dangerous and harmful working conditions.

In order to coordinate the individual aspirations of production organizations within the Institute of Machine-Building Science and Research, the Hungarian Academy of Sciences has worked out a concept for the design and use of robots in Hungary. This concept is part of the machine-building and technological program of the state interim research and design plan. The general contractor for development, improvement and techniques for use of robots as well as for international cooperative work is the "Tungsam" Combine.

Some of the results of the development and use of industrial robots in the German Democratic Republic and the creation of a robotics data bank were



discussed by the East German specialists D. Otto and W. Walter in their article.

The 10th Congress of the Socialist Unity Party of Germany set the main directions for further robotics research in that country. It has planned the creation and use in the GDR of 40,000-45,000 industrial robots before 1985 and the liberation of more than 100,000 workers and their subsequent reassignment to other workplaces requiring higher qualifications.

In June, 1981, the GDR Council of Ministers made the decision to create coordinated centers of robot technology and in August of that year, a decree was issued on the creation of a central robotics data bank. The data bank gathers and passes on knowledge and experience gained with East German and international robots in such areas as the international level of development and use of robotics, robotic technology developed and under development and robotic technology developed in the GDR, the use of robotics in the GDR and imported industrial robots (including data on the technological parameters and economic results of robot use).

The article by G. Andrzejewski discusses robots developed by the Polish Institute of Precision Machinery, their use and designs.

In his article, USSR Academy of Sciences Correspondent Member E.P. Popov describes a system for training and retraining robotics engineers. A significant role in robotics specialist training should be played by the recently established "Robototekhnika" Scientific-Educational Center of the USSR Academy of Sciences and the USSR Ministry of Higher Education which has not only united academic and educational forces for the resolution of current practical problems in the creation and use of industrial robots but will also provide general methodological supervision in the training of specialist cadres and itself retrain robotics engineers and improve the qualifications of teaching and industrial management cadres in the field of robotics.

Articles by other Soviet authors such as E.G. Nakhpetyan, Y.A. Shifrin, A.I. Korendryasev and others examined the methods of testing and diagnosing industrial robots, the experiences of designing and using robotic complexes in industry, the peculiarities of designing control systems for robotic devices and some other current problems in machine building.

The second issue of MASHINOSTROYENIYE continued work by CEMA member-nation scientists and specialists on the problems of robotics and automated production.

The article by CEMA Secretariat Colleagues Z. Vatsek, M. Lefler and R. Lavrov describe the problems of the leading directions for CEMA member-nation cooperation on machine building. The direction taken here is toward preferred development of research and design work, production specialization and cooperation within a series of progressive forms of machine production including robotics and energy-conservation equipment to provide more rational and economic use of fuel and energy.



In the article by Y.I. Yurevich, chairman (general designer) of the CEMA Council of Chief Industrial Robotics Designers, describes the tasks of this council as well as the directions taken in scientific and technological cooperation in the creation and broad introduction of industrial robots into the national economy, the successful implementation of which requires the organization of cooperative production and mutual cooperative deliveries of industrial robots with the use of technological complexes and separate components.

At the beginning of 1983, the Council of Chief Industrial Robotics Designers performed necessary work and presented some preliminary considerations on the robotics specialization to be taken by the individual CEMA member-nations. The Council has expanded its activity and the organizational period has been concluded: a team of national representatives and the leaders of national program and chief robotics organizations. At the same time, national branches of the Council began to operate. In perspective, it will be a great undertaking to realize the prepared concept for technological development of industrial robotics in CEMA nations and to develop international specialization and cooperation.

The article by Czech specialists S. Pollak and D. Kovac discusses Czech-Soviet scientific and technical cooperation on robotics. This cooperation is being carried out in accordance with contracts for joint work on industrial robots and manipulators. The first achievement of this cooperation was the reduction to two years of the research-development-manufacture-introduction cycle. The creation of industrial robots and manipulators through cooperative research made possible coordination of the goals and tasks of specialization and cooperation.

In the authors' opinion, for these important tasks in robotics to be fulfilled, it is necessary to undertake higher forms of cooperation based on contract work. For this purpose, temporary international scientific and technological collective, the "Robot" Design and Construction technological Bureau, was created within the VUKOV [not further identified] Metallurgical Institute (Presov, Czechoslovakia) under the coordination of the Czech State Commission for Scientific, Technical and Investment Development and the Soviet State Committee on Science and Technology. This body's activity will be oriented at the development of FMS based on roboticized technological complexes. The integration of Czech and Soviet specialists within the "Robot" Design and Construction Technological Bureau will make it possible to cut the time spent on designing FMS of roboticized technological complexes in comparison with their individual development.

An article by USSR Academy of Sciences Member K.V. Frolov reviews both the successes achieved by modern machine building and mechanical engineering that have led to great breakthroughs in various branches of the national economy as well as certain problems of automation and the creation of personnel-free production and new problems of machine dynamics and mechanical engineering and in improving the reliability and service life of mechanical equipment.

In articles by I. Marton, I. Rudas, and A. Bencsik (Hungary), V. Cardei and C. Angelescu (Romania), H. Buschbock, K. Rudolf and J. Fogt (GDR) and E. Granicki

(Poland), the production concept of automated and integrated production of parts is characterized, the problems of designing robot-equipped work places are examined and some particular types of industrial robots are analyzed.

Specialists from Czechoslovakia have analyzed a series of problems connected with the study of industrial robots and robotic complexes (V. Cop, J. Smrcek and V. Soltys), control systems for industrial robots and manipulators (I. Mindos) and auxiliary manipulating devices for roboticized technological complexes (K. Kravec, J. Demeter).

USSR Academy of Sciences Correspondent Member Y.P. Popov looked at some examples of the use of various aspects of data-processing in robotics, including robot sensory systems, microprocessor data-processing and the formation of control signals to manipulator drives and gives the characteristics of the data-processing/control parts of some prospective FMS.

This issue of MASHINOSTROYENIYE also contains a series of articles by other Soviet authors on the problems of coordinated-parametric control of manipulating robots, software for automated production with FMS technology, diagnostic methods of studying industrial robots and several others.

Beginning in 1985, two issues of MASHINOSTROYENIYE will be published every year and available for subscription anywhere in the world. The journal will include articles on the problems of the durability, and service life of supporting structures and reduction of metal content, vibration and vibration technology, tribology and tribotechnology and the introduction of FMS, robotics and automated designing and machine-building systems.

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CSO: 1823/124

ROBOTICS

UDC 621.7.077:621:658.2(043):003.13

HIDDEN COSTS OF ROBOTIZED PRODUCTION SYSTEMS REVEALED

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 12, Dec 84  
pp 26-27

[Article by Engineer G. D. Kutsev under rubric "Economics and Organization of Production": "Economic Conditions For the Introduction of Industrial Robots"]

/Text/ The Tyumen branch of the TsKPTB /Central Technical Planning and Design Bureau/ "Medoborudovaniye" /Medical Equipment/ has been working on the topic, "Investigation of the Feasibility of Introducing Industrial Robots in Sections of Shops With Numerically Controlled Machine Tools in the Production of Medical Equipment."

Workers of the Tyumen branch performed economic studies aimed at establishing the dependence of the economic gains from the use of industrial robots on the price, workload ratio, and productivity of the robotized systems.

The estimates were carried out according to a methodology of the Experimental Scientific Research Institute of Metal-Cutting Machine Tools for six robotized systems (see table).

Robot model	Machine tool model	Number of adjustments
RPM-25	2R 135F3-1 drill	3
RPM-25	6520F3-36 milling machine	2
RPM-25	16K30F325 lathe	1
RPM-25	1P752MF3 lathe	1
RPM-25	6520F3-36 milling machine	1
BRIG-10	1713F3 lathe	1

The computation results are presented in Figs. 1-3.

Fig. 1 shows the dependence of the economic gains on the workload ratio of a robotized system for the case of unit productivity, i.e., when the productivity of a numerically controlled machine tool manned by an operator is equal to

that of the robotized system. It can be seen that in this case none of the robotized systems yield economic gains, although the loss decreases with increasing workload ratio.

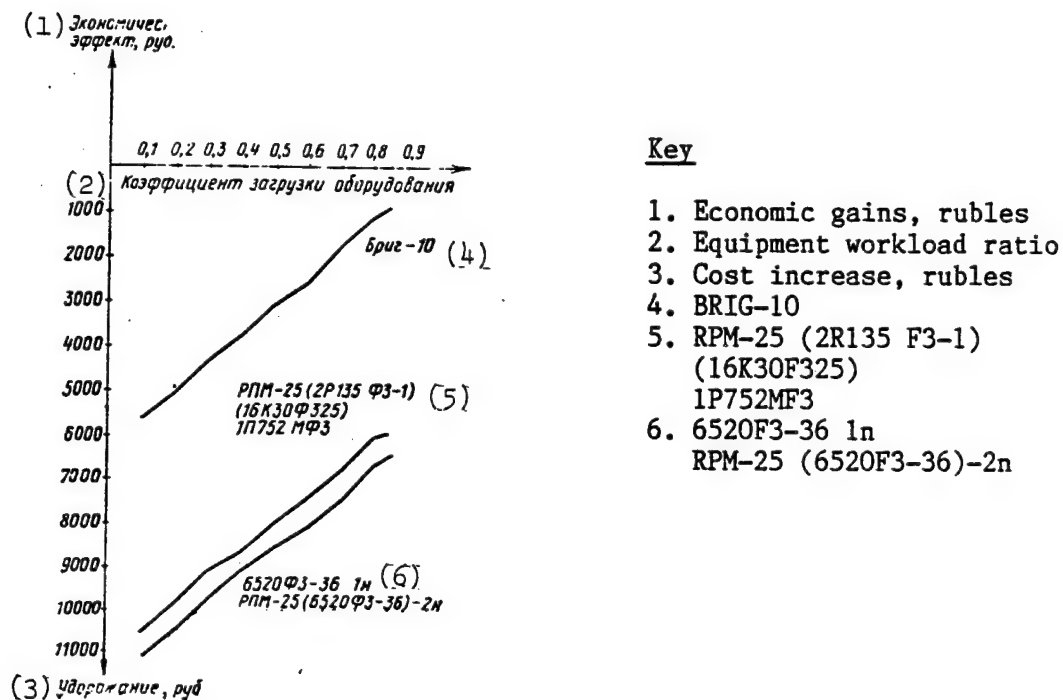


Fig. 1. Economic Gains Yielded by Introducing RPM-25 and BRIG-10 Robots as a Function of the Workload Ratio.

Fig. 2 shows the dependence of the economic gains on the price of the robots for an equipment workload ratio of 0.85 and unit productivity. It can be seen that the use of robots becomes economically feasible if the price per robot is under 9,000 rubles.

Fig. 3 presents the dependence of the economic gains on the increase in productivity of the robotized system for 0.85 workload ratio. It can be seen that robotized systems become efficient when productivity is increased 1.25- to 1.3-fold.

A technical and economic analysis led to the following conclusions:

1. The use of industrial robots in the manufacture of medical equipment becomes economically feasible only at peak equipment workload ratio.

2. Industrial robots can yield economic gains provided labor productivity increases not less than 1.25- to 1.3-fold.

3. Industrial robots become economically feasible when priced below 9,000 rubles.

Currently many ministries are engaged in building and introducing industrial robots. However, manufacturers supply industrial robots without the necessary non-standard equipment and fixtures.

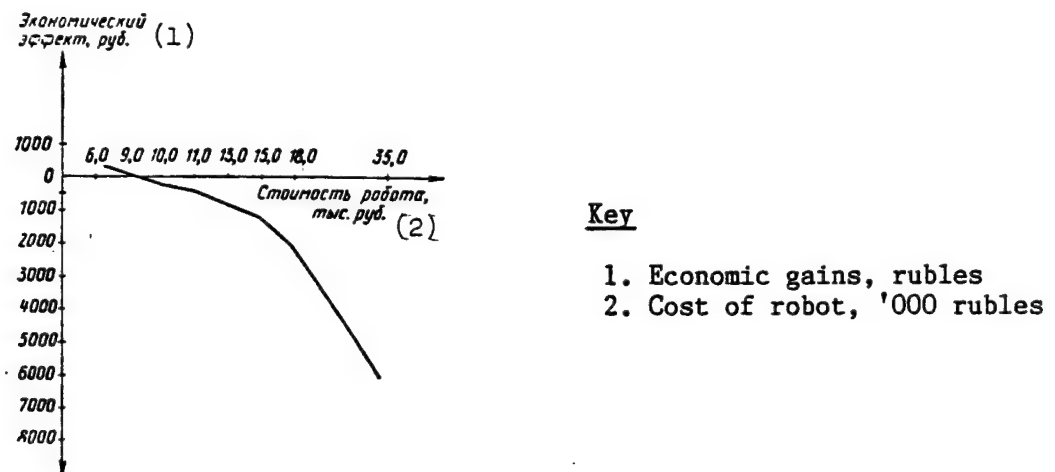


Fig. 2. Economic Gains Yielded by Introducing Robots as a Function of Their Cost (at 0.85 Workload Ratio).

All installation is done by the plants themselves or with the help of branch institutes. To install industrial robots a plant must have a team of at least four or five engineers and technicians.

Taking into account that in our country there are 43,000 production and scientific-production associations, combines and plants with independent balances, countrywide the introduction of a single industrial robot at every plant would require some 215,000 trained specialists, plus support personnel.

Experience shows that the introduction of an industrial robot takes one year to eighteen months and at best eliminates one job. Countrywide, such a system of introducing industrial robots would, within the first eighteen months to two years, require 215,000 engineers and technicians (to say nothing of support personnel) to introduce it while eliminating 43,000 jobs. The result clearly does not favor such a system of introduction.

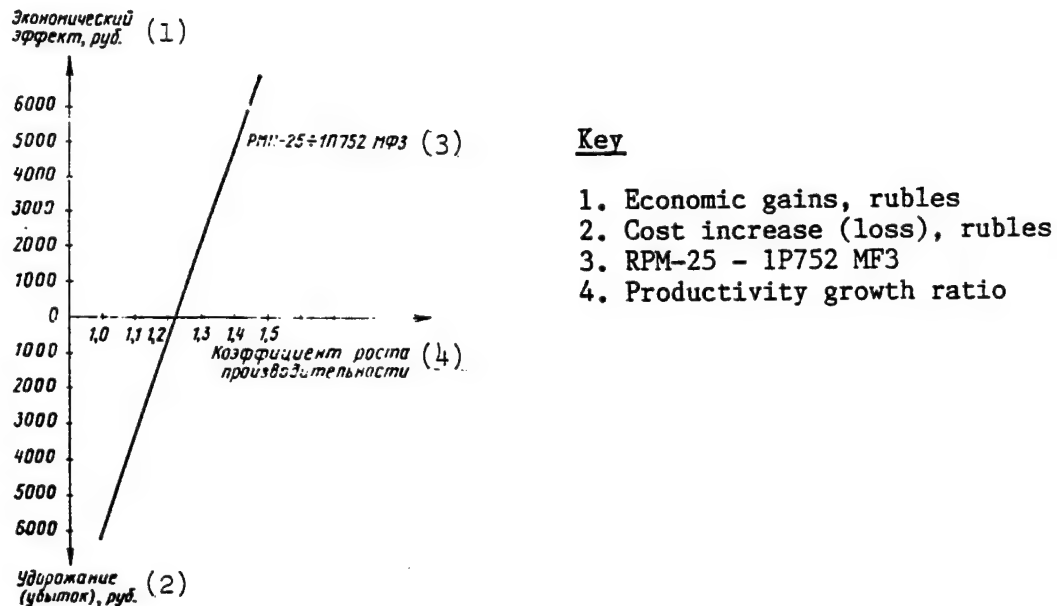


Fig. 3. Economic Gains Yielded by Introducing Robots as a Function of Productivity (at 0.85 Workload Ratio).

This example of introducing industrial robots has been cited to demonstrate the need for a better thought-out system for all plants of the country. On the other hand, instead of the expected economic gains, pursuance of such a policy could yield unjustifiably large losses in both living and embodied labor. What is the reason for this?

To introduce industrial robots (for example, on numerically controlled machine tools) it is necessary to carry out a number of jobs, namely, develop the designs, manufacture non-standard equipment and fixtures for the machines, modernize the basic equipment, design and build a control panel to hook up the basic equipment with the robots, if necessary design and manufacture grasping devices for the robots, design and build a safety system for the robotized complex, design and build a system for controlling the geometric dimensions and surface finish of machined parts, if necessary design and build a system for removing shavings, etc.

It has been estimated that the cost of designing and building everything necessary for introducing industrial robots is, at best, half the cost of the robots themselves. That is because every plant will be doing all this only for itself. One wonders whether it wouldn't be better to develop standard project designs for introducing industrial robots according to specific classes and groups of parts, equipment, and robots. All the fixtures and non-

standard equipment should be built on a centralized basis and supplied together with the robots. The idea is to sell not a just robot but a complete operating system for machining parts of specific types or performing specific operations.

Only such a system of introducing industrial robots can eliminate numerous unnecessary losses.

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CSO: 1823/133

## PROCESS CONTROLS AND AUTOMATION ELECTRONICS

### BENEFITS FROM IMPROVED NC/CNC PROGRAMMING TECHNIQUES

Moscow MEKHAIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 1, Jan 85  
pp 25-26

[Article by E.M. Isachenko, L.Y. Sviridova: "Automating assessment of the economic effectiveness of using NC equipment"]

[Text] In order to determine the feasibility of creating and effectively using metal-working machinery with automatic tool-changing systems, it is necessary to make a detailed economic analysis.

Such an analysis entails establishing the technical and economic indicators of the effectiveness of NC-tools and determining the feasibility of manufacturing specific parts with NC equipment. This is carried out by group centers for NC-machinery programming which are developing control programs for NC machinery in machine-industry plants. A large number of calculations of economic effectiveness have been carried out according the "Instructions for determining the economic efficiency of NC metal-cutting machines" (MU2.5-81) developed by ENIMS [Experimental Science-Research Institute of Metal-Cutting Machinery]. Calculating the economic effectiveness of converting production of parts to NC machinery takes about 60-90 manpower hours since this is done manually for the entire product list (about 20-30 appellations).

In order to lower the manpower cost of these calculations and improve their quality, the Kharkov Group Center for Program Development of the Ukrorstankinprom Institute has developed and introduced a program for calculation of the economic effectiveness of converting parts production to computerized NC machinery.

Starting data which has been contractually divided into three groups is used for calculation. The first data group includes general data on the plant for which the calculations being conducted (type of production, number of shifts, percent extra pay, etc.) while the second describes the parameters of equipment models used in calculation (certain standard data on machinery and CNC, their balance cost [balansovaya stoimost'], etc.). The program has been provided with the use of a a packet of diskettes containing a catalog of equipment. Consequently, if a given piece of equipment is included in this catalog, it need not be described in the starting data. During the reading and processing of equipment data, the catalog is corrected and supplemented.



The third group of starting data describes the technical and economic indicators of different variants for working specific parts.

According to the instructions for determining the economic effectiveness of NC metal-cutting tools (MU2.5-81), the effectiveness of converting tool working operations to NC equipment is examined for each part to be produced. It is assumed that the conversion operation (or operations) is carried out on one machine (or several), NC machines included. This approach makes it possible to determine the economic effectiveness of converting the manufacture of parts to multi-operation NC machines with all of their advantages.

The proposed program makes it possible to determine the economic effectiveness of converting the production of parts to several types (models) of NC equipment in one plant. Aside from the results gained from calculations for individual parts and types (models) of NC equipment, the general indicators for the effectiveness of converting operations to NC equipment for the given plant are also considered.

The results of calculations on the effectiveness of conversion are released in three forms of documents, tables of technical and economic indicators. The first form contains the results of calculation for the entire plant, summarized for all models of NC-equipment (the economic effects of reducing production and labor costs and freeing personnel) while the second form gives the calculation results for each given part according to all three basic indicators of effectiveness, i.e. the cost of tool-working operations, capital investment and the yearly savings. Aside from this, the table also indicates a yearly program for the manufacture of a given part and the number of machines required to manufacture parts according to different program variants.

Standard-reference tables introduce the wage rates used in this calculation for average labor, standard costs for attachments and additional data on machinery (effective yearly service periods of equipment, standard amortization deduction, etc.).

The starting data for calculating economic effectiveness is given in special blank forms, perforated onto 8-track punched tapes with the use of a free format. Starting data can be perforated in GOST 10859-64 codes.

The program for calculating economic effectiveness is a set of small program modules joined by a common data base which makes it possible to easily supplement and monitor them. The program has been written in Fortran-IV and partially in Assembler (subprogram for input of starting data). A computer can calculate the economic effectiveness within 1-2 minutes. Full calculation for one plant (starting with the filling out of blank forms with starting data) takes 1.52 hours. The savings achieved from using a computer to perform one set of calculations is 90.5 rubles.

The program for calculation economic effectiveness provides the following service functions. If they are needed, print-outs can be made of starting documents and errors found in the starting data can be diagnosed.

Operating instructions have been developed for using this program in machine-building plants. These include description of the calculations and tables used for calculation according to methodological instructions as well as their order and examples of preparation of starting data for calculation (interested organizations can receive this document on request).

The use of this program at machine-building plants will hasten the resolution of the problem of feasibility and effectiveness of using NC equipment.

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CSO: 1823/137

## PROCESS CONTROLS AND AUTOMATION ELECTRONICS

### DESIGN BUREAU INTRODUCES CAD, BRIGADE METHOD

Moscow MASHINOSTROITEL' in Russian No 11, Nov 84 pp 5-6

[Article by S.N. Pantyukhina: "The creative search for improved machine designs"]

[Text] The technical characteristics of the precision mills produced by the Ulyanovsk Unique Heavy Machinery Plant make them equal to the best produced anywhere in the world. Many of them are equipped with numerical control [NC] and NC automated devices for changing instruments and worked parts. These include, for example, the 65A80F4 and 65A80PMF4 vertical mills with 630 and 1000 mm tables and the 66K25MF4 and 66K45F4 linear milling and boring machines with 2500 and 4500 mm tables which are used to semiautomatically manufacture parts for steam and gas turbines, atomic reactors and step or wheel excavators of up to 250-300 tons.

The machines produced by this plant are continually improved, more precise and efficient. The main goal of the plant employees and chief specialized design bureau for heavy milling machinery is the creation of tool-working centers that can perform various operations such as milling, drilling and boring according to an assigned program, have automated tool-changing systems and function at a higher level of automation and product quality. This goal has been encouraged by the re-equipment of the plant with new technology. It has received 60 NC-machines and an experimental section with three processing centers has been organized. All processes, from the loading of parts into the machinery to the output of finished production has been totally automated.

The high requirements placed on finished production have brought about a creative search for ways of creating better machine designs and this has been accompanied by the brigade organization of work.

By the end of the 11th five-year period, the plant plans involve 70 percent of its employees in collectivized work. Experience has shown that this progressive form of labor organization has had a beneficial effect on worker discipline. The plant personnel has developed a feeling of community and commitment to their shared goals which in turn has produced an atmosphere of comradely support, cooperation and a striving among the workers to improve their professional qualifications and learn new skills.

One of the best brigades in the machine shop is V.I. Shatrov's crew of 11. Almost all of them are highly-skilled specialists. They work quickly, harmoniously and precisely. They take an economy-minded approach to their work, help each other in a comradely manner and do not tolerate poor discipline. They do not waste a moment of working time. At the end of their shift, they do not leave the shop until the plan for the following day has been established and each has received his given assignments. Therefore, if a neighboring section has assembled two machines during their shift, V.I. Shatrov's brigade has finished three. In this brigade, the plan is always exceeded.

At the present stage of development of the machine and tool industry, the higher demands for technical quality, good design and their quicker introduction to use can be fulfilled only if workers are organized into brigades and design bureaus are equipped with modern computer technology. Therefore, the chief special design bureau of the Ulyanovsk plant was one of the first in the USSR to be organized as a brigade.

A series of measures was first undertaken in the conversion to the new form of organization. A comprehensive system of automation and mechanization of design work was introduced. This system covered all stages from planning and design preparation to automated blueprinting and the automation of the most complex calculations and dynamic studies of machinery. This made it possible for the designers to enhance the unification of the designed machinery. Instead of designing and drawing a new part, the designer uses the computer memory to select a similar part from the data bank. This reduces time spent on design work and improves quality while the nomenclature of used parts is reduced. Aside from this, while studying machine arrangements and establishing basic data prior to designing a machine, the designer can use a data bank of characteristics taken from existing machinery and similar foreign models. This information is transmitted to the screens of alphanumerical displays that are directly located in the design shop. Furthermore, the equipment of the design shop with these graphic displays makes it possible to call up not only written information but also drawings of parts or machinery and this greatly simplifies computer assisted work. This makes it impossible for research and calculation work to scientifically produce original machine designs that consider modern requirements and therefore avoid copying existing models.

The use of computer technology has raised the productivity of engineering and design work 8.5 times. It has also made it possible to more precisely study existing machines, to statistically and dynamically analyze performance and to give machinery greater working reliability. Thus, in the creation of a new series of linear and vertical NC mills, the machine weight was lowered 10-20 percent and this saved more than 120 tons of metal in 1983.

At the present time, the automated design system can only produce blueprints for separate parts however, it has now become necessary to begin using drawings of finished assemblies rather than individual parts. For this purpose, the design bureau has received improved computer technology that can work with a greater number of machine parameters and determine the best

designs for reducing the amount of metal used, increase worker productivity and take technological factors into account. These machines even take over some of the work of factory technicians. This shift from the resolution of individual tasks to integral systems will hasten the introduction of new technology and increase the output of high-quality products.

The equipment of design bureaus with modern computer technology has formed the basis for brigade organization of design personnel. Brigades voluntarily organized in sectors brought together the leading designers, engineers and technical designers. Experience has shown that the best brigade size is 12-16 people. In relation to the amount of work they do, brigades can be either specialized or generalized. A brigade contains only people that have worked on an individual work quota system for no less than three months. As a rule, the brigade chief is a leading specialist on the development of most complicated of the studied objects and should be capable of organizing the work of everyone under him according to their qualifications and individual abilities, assign individual tasks and deadlines and assure the scheduled completion of his group's assignments.

Experience has shown that with the introduction of brigade organization, the moral and psychological climate is much improved, work discipline is stronger and the group's interest in the results of its work is increased. The outcome of the brigade's work is influenced by factors such as the use of patents or suggestions for greater efficiency, professional skills, greater economy, higher unification of parts, submission of the design on its first presentation, (ahead of schedule or not). Therefore, if design errors occur, a decision must be made on the stage in which they will be corrected since the brigades bear a material responsibility for this and must correct defects at their own expense. Therefore, even though the designers might have fairly seldom been present during the assembly of the machine, they are now constantly at work in the assembly shops if needed to make corrections to the design of parts that are still being worked.

Material incentives for designers have also improved: the greatest benefits fall to designers that make the most contribution to the development of a project since a brigade's wages consists of a tariff part [tarifnaya chast'], depending on official salaries of the brigade members, the actual time worked and extra earnings from design and construction work done by the least number of persons. The order of payment is as follows: for the time spent working on a given assignment, wages are awarded in the form of an advance for each object worked on; for scheduled or early completion of projects, 30 percent is added to the extra earnings received in a given month; after the working design is submitted, another 30 percent is added; the remaining sum is paid out after the machine is manufactured from metal (and is of high quality). In the distribution of extra earnings, the KTU [not further identified] set for each worker is always considered. This coefficient is determined according to the volume of work and the period in which it was submitted. The KTU is thoroughly discussed by the brigade council and the decision is later announced to each worker. This style of payment gives the brigade an interest in quick, high-quality work with less labor costs.

Analysis of the introduction of brigade organization for design work has shown that creative potential was significantly increased. Socialist competition and a communist attitude to work (about 90 percent of the designers were involved in this type of competition) was activated, a feeling of responsibility for results was engendered, personnel turnover was reduced 1.5 times, wages were increased an average 9.2 percent, productivity by more than 10 percent and the amount of work achieved by the same size brigade went up 20 percent.

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CSO: 1823/130

## PROCESS CONTROLS AND AUTOMATION ELECTRONICS

### SYSTEMS CONTROL COMPONENTS FOR FMS DETAILED

Moscow MEKHAIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 5, May 84  
pp 2-3

[Article by N.I. Artemov, A.I. Cherepanov, Y.R. Dadiomov: "Design principles and structure of a control system for flexible manufacturing"]

[Text] The creation of GAP [flexible manufacturing systems -- FMS] is the central mission of automation at the present time. The construction of GAP is based on the widespread use of industrial robots and computer technology.

At the present time, GAP has become most developed in machine building, radio technology, electronics and other industries with discrete production. At the same time, the majority of production by various industries is continuous-discrete.

It should be mentioned that, prior to the appearance of GAP, industry made wide use of automated production control systems (ASUP), computer-aided design systems (SAPR) and automated technological process control systems (ASUTP). The low efficiency (in many cases) of ASUTP, even when a process control computer complex (UVK) is used, is explained by the fact that manual labor is still used in many operations. Existing automated systems have not fully replaced personnel in production processes. This has only been made possible by the appearance of industrial robots. The creation of GAP is a combination of the achievements of ASU, SAPR and ASUTP.

Implementation of continuous-discrete production (NDP) has many advantages. This article examines some of the principles for designing a NDP GAP, its structure and functions, problems and the prospects for their development using the example of a plant with continuous-discrete production.

Normally speaking, continuous discrete production can be broken down into a series of stages (phases) with either continuous or discrete (machining or assembly) processes. There are pauses between phases. Interphase processes are often executed manually. The NDP production cycle is rather long, for there are lag times between the intermediate dimensions of the work piece and the parameters of the finished product.

In building a NDP GAP, it is necessary above all to determine the correct arrangement of robotic systems and ASUTP. Robotic systems (RTS) should be used to automate interphase operations and for machining of parts and assemblies. The technological process of assembly is organized on the principle of group technology and consists of assembly centers, transport and technological modules, automated storage systems and industrial robots. Automated technological process control systems are created in phases with a continual technological process.

Computer-controlled robotic systems are linked to the ASUTP minicomputers for the separate phases from which signals are received at the start of work dictated by the given program for the given type of production piece.

An important principle is the decompositional approach to construction of the hierarchical control system for GAP. This principle is used to build a heuristic algorithm for subdividing the GAP control systems into levels. For example, the control system for a NDP GAP assumes that the following levels of control are available:

- control of robots, assembly centers, automated lines using microcontrollers;
- automated control system of the technological processes of separate phases, control of transfer lines, automated storage facilities using minicomputers;
- control of the entire GAP minicomputer or main frame computer.

The upper level of the GAP control system is conditionally divided into subsystems of operative planning and control, reliability control, safety, quality, etc.

At the middle level, ASUTP breaks down into:

- data functions (centralized control of the condition of equipment, transport devices, movement of materials, measurement of technological parameters);
- control functions (control of equipment drives, the switching on and off of technological modules, quality control, organizational recommendations for the technological process of GAP).

The upper level feeds the middle level information on the start-up of production, optimal technological parameters, etc.

The middle level feeds the upper level information on the actual status of production, the state of equipment and flow of materials.

The lower level controls the assembly centers and robots, the middle level gives out signals on the start of work, the type of item being produced. This level also relays information on the conclusion of operations, possible defects or rejects.



The principle of flexibility in the construction of a NDP GAP presupposes flexibility of both the robot mechanisms and the entire control system.

Adaptive robot mechanism is understood to include the ability of being instructed to change the tooling as demanded by the type of production. The robots are sensitized and should be adaptable to the work environment and able to function in indeterminate situations. Flexibility in the robot control process consists of the recognition of objects and their properties, regulation of forces, distances, directions, speeds, etc. In robots with artificial intelligence, this consists of recognition of modelling of the situation, prognosis and subsequent acceptance of optimal solutions.

Flexibility at the upper levels of the GAP control system consists of the adaptation of static and dynamic mathematical models according to which the optimal control of the technological processes in phases is executed. Static models, which usually take the form of regression equations, are used at the upper level to work out the optimal values of technological parameters. The parameters are fed as a set to the phase regulation systems at the middle level where they are optimized under dynamic conditions.

Still another principle of GAP construction, the optimal principle, is realized in this manner.

One of the basic functions of GAP design is to provide the system a certain level of reliability. This principle is realized in the following manner. At the lower and middle levels, a computer is used to limit the diagnosis of irregularities and to replace malfunctioning elements. The middle level produces a set of data on malfunctions and calculates the basic parameters of system reliability (average work time per breakdown, the probability of trouble-free operations, the coefficient of readiness, down time, etc). Based on a prognosis of reliability indicators and their comparison with standard figures, a decision is made to start production.

The upper level calculates the reliability indicators of the production process as a whole, analyzes malfunctions and their causes and classifies them. Aside from this, the middle and lower levels should automatically maintain reliability, and in particular:

--control and automatically adjust equipment;

--test equipment;

--monitor the performance of macrocommands by means of a built-in active control system, etc.

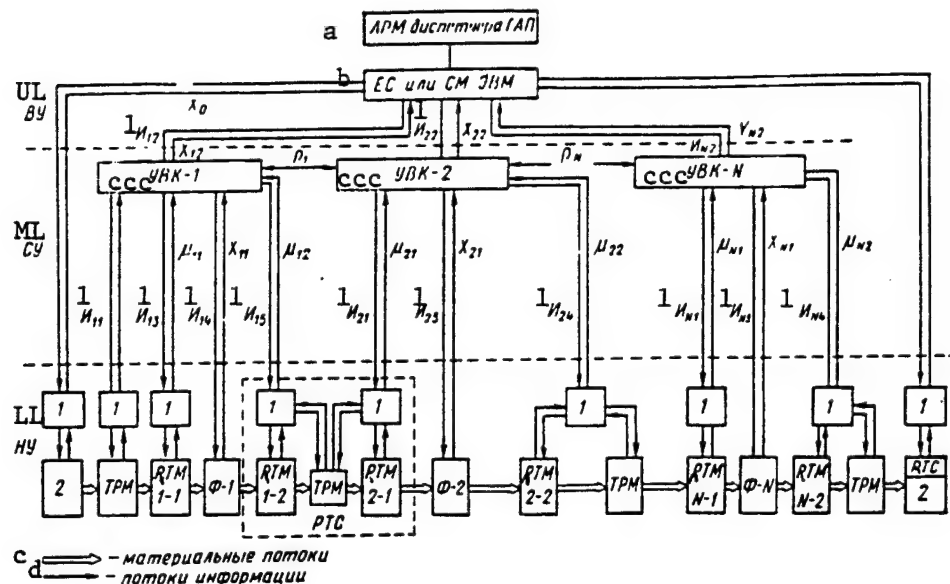
The principle of aggregate-module construction of NDP GAP is based on the use of standard robotic complexes and an ASUTP. A total set of such complexes and systems ensures full automation of production. Particular attention here should be paid to the creation of interphase robotic systems.

The structural layout of the control of NDP GAP, based on the principles described, is illustrated in the included figure.

GAP has undergone rapid development. What problems have occurred in the development of GAP and which have been solved? The following can be mentioned briefly: the working out of methods of decomposition and optimal synthesis of the GAP structure, development of high-speed, usable algorithms for robot instruction and identification of mathematical models of static and especially dynamic processes; the problem of the interconnection of technological means of control, their software, program automation, reliability and social problems associated with the introduction of GAP and the problem of sensitizing robots, etc.

We can still expect to see the widespread introduction of GAP and smart robots in all areas of our national economy. Problems have arisen in the close interconnection of computer-aided design systems and GAP for the purpose of forming flexible systems for the design and production of a broad class of items.

It has been planned that over 50,000 industrial robots will have been introduced by the end of the current five-year period. The unification of robotic systems with ASUTP and SAPR will make it possible to create efficient adaptive and flexible production of the continuous-discrete type.



Layout for the control system of a NDP GAP: UL, ML, LL -- upper, middle and lower control levels;  $\phi - 1, \phi - 2 \dots \phi - N$  -- technological phases of production; TRM -- transport--robotic module; CCC -- control computer complex; X -- technological phase parameters; Y -- produced item quality parameter vector; I -- control;  $\mu, \rho$  -- minicomputer signals; 1 -- minicomputer; 2 -- automated storage; RTM -- robotic technological module; RTS -- robotic technological system; a -- automated work site of GAP dispatcher; b -- unified system of small computers system; c -- material flow; d -- data flow.

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CSO: 1823/2

TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION

UDC 658.511:658.5.011.56

ECONOMIC BENEFITS OF MANAGEMENT AUTOMATION VIEWED

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 2, Feb 85  
pp 29-31

[Article by T. G. Sheshukova and I. I. Katayeva, candidates of economic sciences, "Economic Analysis under ASUP Conditions" ]

[Text] An important problem in production control is the achievement by each management link of the production association, the enterprise, of maximum results with minimum costs. Of special importance in this connection is the direct connection between production management and the realization of unused reserves. Economic analysis is an efficient means of searching for and mobilizing production reserves.

Under ASUP [Automated System for Enterprise Control] conditions, management does a regular analysis of the economic environment in which the links function (enterprise, shop, section or brigade).

ASUP development is signified by the transition to the third generation of computers, the development of data bases, the origination of an integrated ASU [Automatic Control System] and the aggregation of enterprise control systems with technological process control systems. This is characterized by an increase in the number of developments, the reduction in their schedules, and costs by using applied program packets and typical developments, the expansion of the spectrum of problems being solved, and the use of a computer network with distributed data bases.

However, frequently, the actual effect of introducing ASU does not reach the rated effect and, in a number of enterprises, is only 14 to 25 percent.\* Below are shown results of ASUP introduction, developed by the Perm' "Parma" NPO [Scientific Production Association] in 1976-1982 (Table 1).

\* Chumachenko, M. G.; Zabolotina, R. I. Economic efficiency of ASUP. Moscow. STATISTIKA, 1977, p 78.

Table 1

Controlled object	ASUP efficiency, planned in TZ, 1000 rubles	Actual ASUP efficiency, 1000 rubles
GPZ-10 State Bearing Plant (Rostov)	730	104
Control Computer Plant (Tbilisi)	860	220
Calculator Plant (Smolensk)	600	150
GPZ-20 (Kursk)	1070	697
"Schetmash" Plant (Kursk)	900	200
Calculation-Analytical Plant (Ryazan')	1500	550

We will dwell on several established trends and economic development problems in the process of organizing ASUP and the automation of analysis functions, which, in our opinion, reduce the efficiency of automatic control.

It is known that the organization of an ASUP begins with analyzing the existing control system with the goal of defining automation problems. An especially large volume of analytical work is executed in the project stage, which includes technical-economic substantiation (TEO) and the development of the technical task (TZ) for creating an ASUP. At this stage, there are analyzed the organizational and production structures of the enterprise, the functions of the subdivisions and services, efficient planning methods, operational-dispatcher control, accounting, material incentives, material responsibility, etc. As a result, the most urgent directions for improving the control mechanism at the enterprise are determined, as well as the rearrangement of cost accounting relationships at the production unit level, shops, sections, brigades and work positions. The composition of the automated problems and the degree of their effect on increasing the efficiency of production are substantiated; recommendations are made on changing the organizational structure. Analytical work is very diverse and requires extensive knowledge in the field of economics, organization, analysis and production control.

The costs of preproject investigations together with the development of a technical task involving general industrial methodological materials for creating a standard ASUP are 16.7 percent of the total labor-intensiveness of its creation.\* The actual unit labor intensiveness for preproject work on the ASUP developed by the Perm' "Parma" NPO is shown in Table 2 (in percent).

\* General industrial guiding materials on creating ASUP. Moscow. STATISTIKA, 1977, p 240.

It follows from Table 2 that the ratio of preproject work to the total ASUP cost is lower than the ratio of its total labor-intensiveness. Therefore, at this stage, developers more frequently execute only that volume of work which is provided financing. In our opinion, in order to avoid such a contradiction, it is necessary to make the relative ratios of preproject work in costs and labor-intensiveness more in conformance.

Table 2

Name of System	Control object	Ratio of total ASPU cost	Ratio of total labor-intensive-ness
ASU-Turbodetal'	Poltava Turbine Machine Plant	10	13
ASU-Elva, Tbilisi	Control Computer Plant	10	19
ASU-Termopribor Klin	"Termopribor" PO	8	11
ASU-GPZ-20, Kursk	GPZ-20	9	7
ASU-Kamkabel-2, Perm'	Kama Cable Plant imeni 50-letiya SSSR	6	14
ASU-Energomash	Belgorod Power Machinebuilding Plant imeni Lenin	10	14
ASU-Kopeysk	Machinebuilding Plant	4	12.5
ASU-PZMK, Pervoural'sk	Metal Structure Set Plant	11	19
ASU-Avtosamosval, Neftekamsk	"Avtosamosval" Plant	10	20
ASU-Telemekhanika, Nal'chik	"Telemekhanika" PO	6.6	10
ASU-Tochmashpribor, Armavir	"Tochmashpribor" PO	7.5	11
ASU-Khar'kov, Tochpribor	Precise Instrument Building Plant	10	20

However, as may be seen from the Table, to standardize design work, the cost of preproject work is put too low and does not even correspond with the standard one, while actually the costs are still lower.

The practice of the "Parma" NPO shows, for example, that it takes two developers one month to investigate the technical-economic planning (TEP) subsystem. In a number of systems during the same period, they can investigate, along with the TEP subsystem, a subsystem for the technical preparation for production. An investigation of operational control and material-equipment supply subsystems can be done in one man-month and the same time is spent on accounting

and personnel control. This obvious disproportion leads to the fact that at the technical project stage about triple the time is spent on additional investigation which, at times, changes not only the initial project solutions, but also the configuration of the system (composition of problems, arrangements for their correlation). The result of this may be a correction of TZ during the engineering project stage which prolongs the time for the project development without justification or can make obsolescent a system not yet introduced.

A widely spread error in developing ASUP is the urge to reduce the time and costs for studying the existing system and the underestimation of the necessity for this study. The fact is also not taken into consideration that precisely at this stage is the foundation laid for the successful introduction of the ASUP. The reduction in time and cost of the preproject development stage is due to a relatively small volume of bookkeeping. For example, only two documents are prepared at the preproject stage, while at the engineering project stage 12 documents are developed for the system, two documents for each subsystem, two -- for each problem and 18 kinds of planning estimates.\*

Reserves in control and production are identified in the process of a comprehensive analysis of the existing control system. New production and control organizational forms for management, based on modern computers, are determined.

Using industrial methods, ASUP design by using automatic functions, becomes a tool to improve methods for solving problems. The introduction of group projects assumes the standardization not only of documents for data processing technology and the composition of the data, but also for planning, accounting and analysis.

For example, methods for determining cost accounting indicators for the same type of the "Soyuzschetmash" VPO enterprises are diverse. Thus, planning and accounting of commercial output in shops of the Ryazan' Calculating and Analytical Machines, Lenin's Medal winner, are done on the basis of standard wages; at the Smolensk Calculating Machines Plant -- in norm hours; at the Penza "Elektromekhanika" PO -- in plan-accounting prices; at the Kursk "Schetmash Plant -- in standard-wholesale prices. The methodology of calculating intraplant prices is also different and is defended by each plant under the pretext of the specific nature of production. The determination of the methodology of organizing intraproduction cost accounting in ASUP for groups of single-type enterprises must be executed by ASUP developers together with the scientific institute of the industrial sector which carries out the methodological development of a given problem.

Insufficient analysis of individual components of the control system leads to retaining traditional forms of accounting and reporting, and to reflecting algorithms of the established control forms and methods in the developers. The experience of the developer is basically taken into account when the problems are formulated and an extensive scientific analysis is made of the entire

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\* ASU technical documentation systems. USSR State Committee on Standards. Moscow. Standarty, 1980.

control system. The designed enterprise control structure differs from the existing one, as a rule, by the addition of new subdivisions that implement functions on automatic data processing. All this, in the final account, does not facilitate the main goal of automation, precisely an increase in the efficiency of production and of the control system.

A shortcoming of the methodological nature of the functional part of ASUP is also the indefinite place for economic analysis in the ASUP.

The ORMM on creating ASUP does not specify an independent subsystem for comprehensive economic analysis.

Practice shows that in the ASUP being developed and in the existing ones, a small number of analytical problems exists in functional subsystems, each of which (besides the TEU subsystem) includes planning, accounting and regulating individual sides of production activity.

From our viewpoint, it is expedient to utilize to a maximum positive moments contained in these or other approaches. It is impossible, however, to agree with a methodological selection of one or another method for automating economic analysis problems (separation of an independent comprehensive analysis system, etc.), in which, as a basis, a more perfect ASUP software or a single structure of software (data bank), or the location for data origination are selected.\* Without question, there is an internal relationship between the system parameters, but it is secondary. In determining the location for the ASUP economic analysis, it is necessary to base it on the characteristics of the controlled object; determining in this case the scale and repeatability of the kinds of product output, the parameters of the product list and the length of the production cycle. In mass and large series production of the same products, such information models are created that control the material production processes to a maximum extent and to a high degree of calculated substantiation. Management solutions maintain their force for a long time. Established norms reflect actual proportions in production. Methods for implementing functions are distinguished by high algorithmization and definiteness. In view of this, under mass production conditions, it is advisable to solve analysis functions in functional subsystems while their integration can be provided in TEP subsystems and accounting records.

Enterprises with series and small series types of production have a considerably greater number of various situations which may reflect positively or negatively on the objects being controlled. An analysis of production parameters and the identification of the consequences of the solutions adopted for their control are difficult. In view of this, it is necessary to have an automatic subsystem for a comprehensive economic analysis whose function is to implement a feedback between objects being controlled and remaining management functions.

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\* Economic analysis course (Edited by M. I. Bakanov and A. D. Sheremet). Moscow, Finansy, 1978, 203 pages.



It follows from what was cited above that the following will intensify the effect of the economic analysis on the scientific technological level of the ASUP.

1. Doing a large amount of research on analyzing and improving organization and control methods within the framework of target programs in cooperation with highly skilled specialists.
2. Increasing the time for preproject investigations since the automation of management processes must rely upon their extensive scientific knowledge and a wide study of advanced production experience. At present, a specific developer reports on TEU and TZ stages only the description of the existing control system and a list of problems selected for automation. This leads to the fact that the creation of technical economic models and solutions in principle are not monitored at these stages and frequently are not even planned. At the preproject stage, it is necessary to formulate in a way that would include the purpose of the problems complex, the utilization of the solution results, and the output and input data. However, at the engineering project stage, it is necessary to develop algorithms and general system documents.
3. Expanding the scope of analytical functions being automated.
4. Determining location of the economic analysis in a specific ASUP, based on parameters of the object being controlled.

An improvement of the economic analysis in the ASUP will facilitate the efficient utilization of all kinds of resources in the production process; insure a clear-cut and coordinated interaction between all subdivisions for attaining a common goal in the enterprise control system.

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CSO: 1823/138

TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION

BOOK ON AUTOMATED PRODUCTION MANAGEMENT REVIEWED

Moscow MEKHAIZATSIIYA I AVTOMATIZATSIIYA PROIZVODSTVA in Russian No 3, Mar 85  
pp 43-44

[Article by Professor S. S. Brudnik, doctor of economic sciences: "A Comprehensive Approach for Automation Management Systems in Machinebuilding" reviewing book by R. Y. Maksarev and M. Y. Gornshteyn: "Technological Process Automated Control Systems In the Machinebuilding Industry"]

[Text] The re-equipping of production technology in the machine-building industry, decreed by the 24th CPSU Congress and expanded upon by the 25th and 24th Congresses, involves the resolution of complicated scientific, technological and industrial problems by the most effective means possible.

A considerable role in this will be played by complex-automated sections equipped with NC equipment centrally controlled by computers.

On the basis of their own work and many years of experience, the authors of the reviewed book have very precisely and systematically presented the basic concepts and terms used in the science of technological process automated control systems, described the present state of their development, the actual requirements for their construction and their methodological problems.

The authors present a new point of view on the growth in automation of technological equipment, the conception and development of the automation of control systems for this equipment and its aggregates (complex sections). Up to now, this has not been properly considered in specialized literature.

The authors very convincingly show that the automation of machine control systems is useful if the given technological potential of a plant is high enough. This potential can only be realized if technological equipment is created that is oriented at the use within the given system of machinery equipped with special adaptive process automated control systems.

The position taken by the authors compels one to thoroughly reconsider the choice of which objects are to be automated and to a large degree prevents inefficient work. The book thoroughly describes the basic methodological, technical and organizational aspects of creating technological process automated control systems [ASTUP]. By combining the authors' multifactor

classification of ASTUP with the simple and lucid form of single-factor coding, one is presented with numerous special forms of its use that are of great practical application.

The authors discuss the problem of the many possible variants for designing automated machine systems. This variability is determined by the broad possibilities that exist for variation of all system components, the types and composition of the basic and auxiliary equipment and its layout, the set of control functions, etc.

Methods are given for determining the feasibility of creating technological systems with ASTUP and selecting basic design variants. The principal feature of these methods is calculation of the technical and technological parameters of the object with regard to the degree of efficiency required. The methods worked out by the authors make it possible to guarantee the effectiveness of automation investment and establish requirements for certain technological characteristics of the created machine systems. Such an approach makes it possible to organize machine complexes according to the type of production, compare them and then select them at earlier stages of design.

In their theory of machine productivity, the authors suggested using a single economic-mathematical model of technical and economic efficiency of systems with NC [numerical control] and ASTUP to determine the inter-relationship of economic indicators and the technological parameters of the machine system. Mathematical relationships are given that have direct practical significance for analysis of the production balance of an NC-machine section in mass production.

A method of stage-by-stage organization of optimal forms for NC-tool and ASTUP complexes makes it possible to successfully solve the problem of increasing productivity.

The complex methodology for determining the technical and economic effectiveness of ASTUP is of special scientific and practical interest.

The substantive element of innovation is to be found in the description of experimental studies on the subject, and the substantiation of the feasibility of automated control, and determination of the factual economic effects. Without these it is impossible to assure the necessary reliability and accuracy of the calculations.

Naturally, such a complicated and comprehensive study is not free of certain shortcomings. For example, its analysis of the development of automation of the technological process control did not consider conditions for the growth of production, specialization, growth in the size of production, etc.

The authors' discussion of problems in creating technological systems with ASTUP left out the important stage of their design automation.

In general, the reviewed book is an interesting and important work and innovatively considers many problems in the most important areas of scientific

and technological progress in machine building and an original approach to their resolution.

The book's systematic approach to technological and economic design work is the first attempt of its kind in the area of designing an object for a given degree of efficiency and if it comes into wide use may promise a large savings by eliminating discrepancies in methods of justifying, designing and analyzing the effectiveness of new technology and reducing the time and cost of creating and using it. The flexibility of the developed methods is much greater than the work indicates. They can, for example, be used in automating the design of sections with NC-tools and ASTUP and in entirely different branches of industry.

The book has much scientific value and will undoubtedly prove useful to a large circle of scientific and technical workers involved in the creation and analysis of ASTUP systems.

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